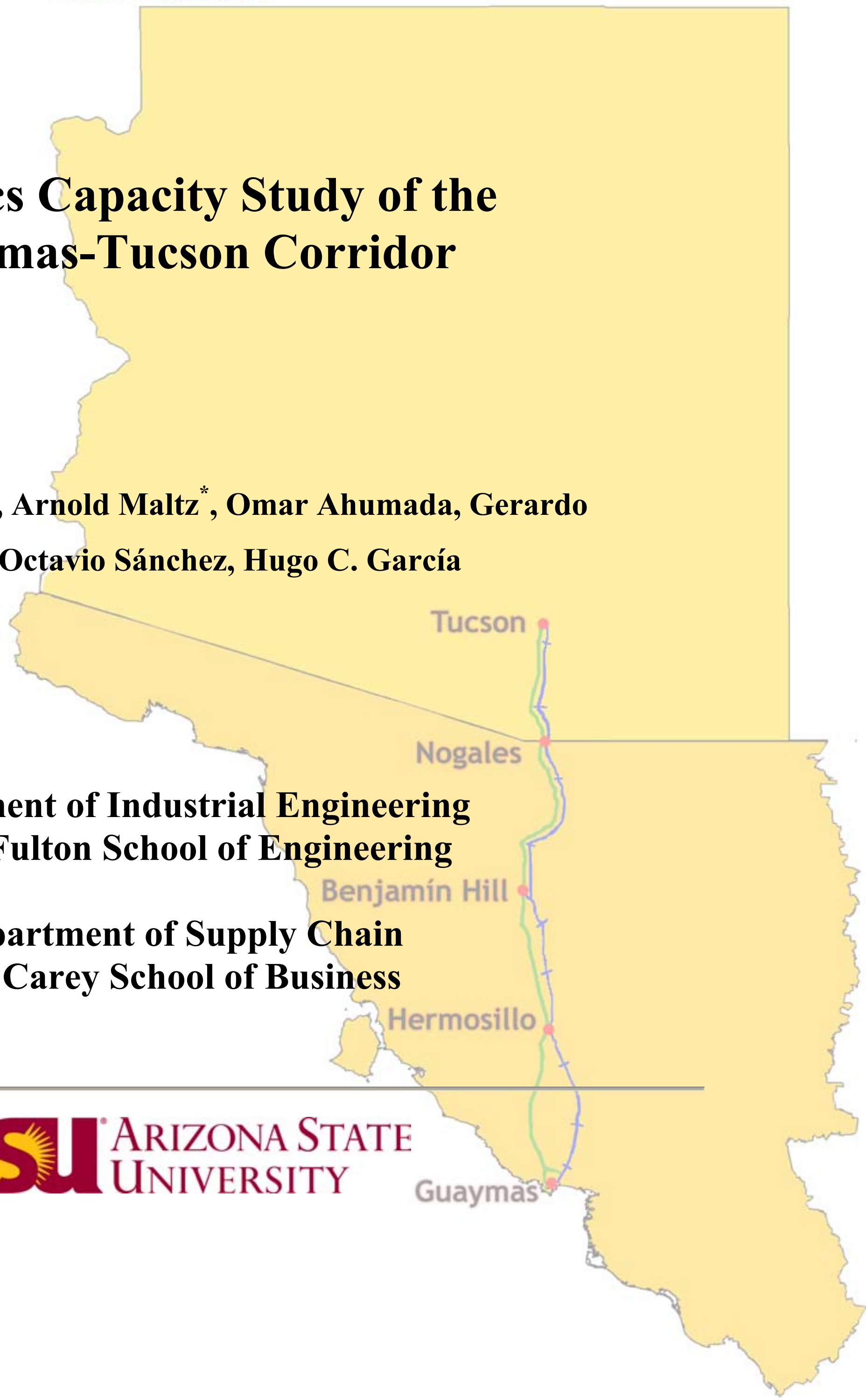
A Report to the Arizona Department of Transportation

Logistics Capacity Study of the Guaymas-Tucson Corridor

J. René Villalobos, Arnold Maltz*, Omar Ahumada, Gerardo Treviño, Octavio Sánchez, Hugo C. García

Department of Industrial Engineering
Ira A. Fulton School of Engineering

*Department of Supply Chain
WP Carey School of Business



ARIZONA STATE UNIVERSITY

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Executive Summary

This document provides the final report of the activities performed under the project *Logistics Capacity Study of the Guaymas-Tucson Corridor* sponsored by the Arizona Department of Transportation (ADOT) under Grant JPA 06-001T. Some of the findings in this document include:

- From an infrastructure perspective, we believe that the Port of Guaymas, with some minor improvements, such as the acquisition of additional container-moving equipment, is ready to start a container service comparable to other Mexican regional ports, such as the Port of Mazatlan and Ensenada.

- However, the main limitation of the port capacity is the current unavailability of quay cranes. This precludes the Port of Guaymas from being able to offer efficient turnaround services to modern container ships that are not geared with their own cranes. This constraint may limit the potential of the Port of Guaymas to serve as an efficient gateway port for container service beyond the local region. In order to provide this service we believe that at least two quay cranes are needed, since just one quay crane would not provide enough capacity to make the loading and unloading of containers from the vessels more expedient. The exact capacity and characteristics of the quay cranes and related issues, such as the need for reinforcement of the piloting system of the port is beyond the scope of this study.

- We estimate that the current main bottlenecks of the physical infrastructure of the corridor, in order of their impact, are: Mariposa Port of Entry (POE), the railroad inspection procedures at the US side of the border and the Port of Guaymas. These points need to be further studied to verify our findings and to recommend potential improvements if an increase of the current capacity of the Corridor is desired.

- We estimate the current capacity of the Guaymas-Tucson multimodal corridor to be 175,000 TEU (twenty-foot equivalent units) per year if both, Mariposa and DeConcini, ports of entry are operational, and a railroad container service between Guaymas and Tucson is available. However, this capacity is reduced to 104,000 TEU per year if a railroad service is not available. On the other hand, the current capacity for the corridor would be of 120,000 TEU per year, if only rail is used to move the containers from

Guaymas to Tucson. In this case, the main factor limiting the capacity of the Corridor would be the train inspection procedures performed at the DeConcini Port of Entry and/or Rio Rico facilities.

- After getting historical data of the usage of the railroad tracks, physically inspecting and analyzing the specifications of the overpasses for the Empalme-Hermosillo railroad segment we could not find any physical obstacle to the operation of double stacked container trains from Guaymas to Tucson.

- A major obstacle for the viable operation of the Guaymas-Arizona container service is the lack of a provider of an integrated service that includes shipping lines, railroads and freight forwarding services. In order to make possible this integrated service it is first necessary to have an integrated railroad service for containers between Guaymas and Arizona. In this regard, we were unable to get precise information from the US rail company providing the service, i.e. Union Pacific, on what are the necessary or sufficient conditions –commercial or operational; to service the potential containers generated by the Port of Guaymas. We believe that the railroad companies are indispensable for the creation of an economically feasible container corridor between the Port of Guaymas and Arizona. Thus, these companies must be encouraged to take an active role in the activation of a container service in the Corridor.

- Input from United States (US) rail and truck managers suggest that process changes to make border crossing times more predictable would be very useful in facilitating efficient services to and from Guaymas.

- We believe that even if container traffic were attracted to the port, US railroads would primarily be interested in Midwest-East destined freight, while Ferromex is willing to handle shorter haul business.

- In our analysis, we have made assumptions about the type of infrastructure and level of service needed to attract a shipping line to establish a port of call by a major container shipping line. However, the exact needs in terms of service and demand should be explored with the shipping companies. This assignment is left as part of the proposed second phase of this study.

- An issue that needs to be addressed as soon as possible is the lack of a regularly scheduled container service to the Port of Guaymas. While the analysis of the requirements to attract a major shipping line to the port was beyond the scope this study, we believe that the geographical position of Guaymas may be an issue to attract, in the short term, a company to provide direct service to Asia. However, we believe that the Port of Guaymas is well positioned to serve as a regional port. For instance, it may be appropriate for Guaymas to concentrate initially on operating as a feeder port for Sonora destined business until regular longer-haul business is instituted by the steamship lines and efficient rail service for containers is secured.

- From the review of previous studies we found nineteen reports related, directly or indirectly, to the Corridor. The main emphasis of these studies is on the infrastructure issues on the border ports of entry and between Nogales, AZ and Tucson; as well as current and potential congestion on the highway Interstate 10 (I-10). However, we did not find any study that directly documented the overall capacity or the competitiveness of the Guaymas-Tucson Corridor.

1 Introduction

This report documents the findings of the activities performed under ADOT Grant (JPA 06-001T). The description of the study is included as Appendix A of this report. The overall proposed study was divided into two phases. The objectives of these phases can be summarized as follows:

- Phase I
  - Make an inventory and summarize the available relevant studies that have been performed on the corridor.
  - Perform a quick operational assessment of the current capability of the Guaymas-Tucson corridor, in terms of Twenty-Foot Equivalent Units (TEU) that the corridor can currently handle.
  - Provide preliminary recommendations for future investments, by identifying current and potential bottlenecks of the corridor, the projects required for solving those bottlenecks and the priority of those projects based on the overall benefits for the corridor.
  - Provide comments on the general feasibility of the Arizona-Guaymas corridor.
- Phase II
  - Expand the study to include prescriptive recommendations in terms of logistics and security practices for the port, which will allow it to become globally competitive as a small container port.
  - Identify how the Port of Guaymas can serve as a strategic point of collaboration between Arizona and Sonora. The benefits of this collaboration might include an increase in the competitiveness of the corridor and attracting higher value added operations to the region.

This report covers the activities performed for Phase I which is the only part funded by Arizona Department of Transportation (ADOT); and it covers the period from August 1, 2005 to April 15, 2006.

According to the approved statement of work, the tasks to be conducted as part of Phase I included the following:

1. Identification, assessment, and classification of previous studies dealing with the corridor.
2. Refinement of tasks to be performed in Phase I.
3. Documentation of current conditions of the Port of Guaymas.
4. Identification of the major infrastructure components of the transportation network between the Port of Guaymas and Tucson.
5. Documentation of the capacity of each of the infrastructure components.
6. Determination of a baseline cargo scenario for the container terminal.
7. Determination of expected transit times between the cities of Guaymas and Tucson.
8. Identification of the bottlenecks and potential improvements in the Corridors' railroad and highway.
9. Preparation of scope of work for Phase II.

In the rest of this report we provide a brief summary of the activities performed to accomplish these tasks.

2 Refinement of Tasks

The proposed initial tasks to conduct the *Logistics Capacity Study of the Guaymas-Tucson Corridor* were presented to the Technical Advisory Committee (TAC) in the inter-plenary meeting of September 30, 2005. Based on feedback from the TAC members these tasks were approved in the TAC meeting that took place on November 22, 2005, at Arizona State University (ASU).

After the objectives were approved by the TAC we developed a set of detailed activities required to complete the scope of work for the project. These activities were:

- Documentation of previous studies related with the corridor.
- Establishing a baseline of cargo for the container terminal.
- Analysis of the current infrastructure of the Port of Guaymas.
- Analysis of capacity and demand at the Nogales Port of Entry.
- Review of highway infrastructure along the Corridor.
- Review of railroad infrastructure along the Corridor.
- Overall Corridor analysis.
- Definition of scope of work of future activities.

The remainder of this report is organized according to these activities.

3 Documentation of Previous Studies Related with the Corridor

The main purpose of this activity was to identify the previous studies having a direct or indirect relation with the Sonora-Arizona corridor so that no redundant work would be done. In order to document and analyze the previous studies dealing with the corridor we did the following:

1. Identification of related previous projects with the help of ADOT in USA and *Secretaría de Comunicaciones y Transportes* (SCT) in Mexico.
2. Reading the projects and develop a matrix that includes the documents researched and their relevant contributions to the current project.
3. Developing a summary of the findings from the past projects.
4. Identification of those areas that have not been covered by previous projects.
5. Incorporation, if feasible, of the identified areas into the current project.

As an initial activity of the *Logistics Capacity Study of the Guaymas-Tucson Corridor*, previous studies were identified, gathered, and summarized. The studies were identified through literature search using citation indices and internet tools, from recommendations from the TAC members, from people with experience in the region, and from citations from the studies themselves. The following is the list of the studies reviewed:

1. Latin American Trade and Transportation Study (1997).
2. Arizona Port Efficiency Study (1997).
3. Impacts of Transportation and Education Policy on Trade and Development in the Arizona-Sonora Region (1998).
4. Arizona Trade Corridor Study (1999).
5. Arizona Rail Plan (2000).
6. US-Mexico Border: Better Planning, Coordination Needed to Handle Growing Commercial Traffic (2000).
7. Intelligent Transportation Systems at International Borders (2001).
8. The CANAMEX Corridor Coalition (2001).
9. Arizona's Border Issues (2002).
10. Nogales International Airport Master Plan (2002).
11. Nogales CyberPort Project: Comprehensive Report (2003).
12. Arizona's Global Gateway (2003).

13. The National I-10 Freight Corridor Study (2003).
14. Transportation/Logistics Research Project: Trade Flow Study (2004).
15. Move Arizona (2004).
16. Guaymas Master Development Plan (2005).
17. Mariposa US Port of Entry Feasibility Study (2005).
18. Nogales Railroad Assessment Study (2005).
19. Container Port Capacity Survey (2005).

One of the tasks included in the Phase I, was to compile a summary of the previous studies (see Appendix B – Study Master List). The project team elected to summarize previous findings using two instruments:

- An Excel matrix.
- A written summary of the previous studies.

These two instruments are described next:

An Excel matrix was prepared with the various studies across the top, and relevant information possibilities in the first vertical column. The Excel matrix (Appendix C) has four separate sheets – Actual Flows, Forecast Flows, Process, and Infrastructure – and the different sheets may reference different information. If a particular study contained relevant information, the date of the information is indicated. For example, the Cyberport Study was completed in 2003, so the actual flow data is labeled 1994-2002. Note that the dates generally refer to the underlying data, rather than the publication date of the specific study. If date ranges are noted, the study includes historical data and/or forecasts for multiple years.

A summary of each study was prepared that describes the main elements of the document and indicates the findings that seem to be relevant to this project. Where appropriate, tables of contents and lists of tables have been copied from the studies for the convenience of the user of this report. It is suggested that readers first look at the matrix to see which studies may contain relevant data, and then go either to the study summaries or the studies themselves to find specific flows, process descriptions, or infrastructure descriptions and suggestions. The written summary is included as Appendix B of this report.

3.1 Summary of Literature Review

Nineteen studies having a direct or indirect relation to demand and capabilities of the Port of Guaymas were reviewed, as well as studies of the logistics network which includes the city of Guaymas. These studies document the lack of growth since 1998 at the Nogales, AZ gateway which is the entry point for United States destination traffic unloaded at Guaymas. Only one study directly examined the Port of Guaymas time and cost competitiveness with California's Port of Long Beach, but several of the studies document the need for improvements to the border crossing process at Nogales, both rail and truck. A number of the studies detail the infrastructure between Nogales, AZ and Tucson, AZ; as well as current and potential congestion on I-10. The studies show that while there is substantial North-South traffic between Sonora and Arizona, the East-West volume through Arizona is larger at this time.

Finally, we did not find any study that documented the competitiveness of the Guaymas-Arizona corridor from the perspective of overall logistics costs nor its overall capacity.

4 Establishing a Baseline of Cargo for the Container Terminal

Since the Port of Guaymas does not currently have a scheduled container service from any steam shipping line we had to establish a hypothetical minimum number of containers upon which to base the overall analysis of the corridor. In order to establish this baseline the following activities were planned:

1. Deciding the minimum demand of TEU necessary to schedule a regular stop at the port.

2. Determining a most likely and an optimistic scenario of TEU demand once the Port of Guaymas starts receiving container traffic.

3. Researching the preliminary requirements necessary (in TEU) to attract a container service company, schedule a stop at the Port of Guaymas.

Regarding activity 3, it was preliminarily established that a weekly demand of 400 TEU would provide the minimum number of containers to be attractive for a shipping company to make a regular stop in the Port of Guaymas. At the same time this number of TEU represents the equivalent of a weekly unit train from the Port of Guaymas to Tucson. We believe that the potential use of a unit container train would help to make the project attractive for Union Pacific (UP) and Ferromex. In addition, 400 TEU per week is also comparable to the current level of business that some shipping companies currently have in other Mexican ports. In this regard, the Ports of Ensenada and Mazatlan were used as direct benchmark references for the potential container business of Port of Guaymas.

The Port of Mazatlan provides a good baseline to analyze Guaymas from the perspective of the current level of port infrastructure. It also provides a good reference point as a regional Mexican port that aims at servicing the local needs and still be attractive enough for international shipping liners to make a regularly scheduled stop in this port. The Port of Mazatlan does not currently have what would be considered a full fledged container terminal –i.e., it lacks the quay, sea-to-shore, cranes needed to provide efficient service to the newer container ships. Instead, it bases its service on the availability of container ships geared with their own cranes to unload the containers to the port. According to official SCT data (*Direccion General de Puertos*, 2005), in the year 2004 the Port of Mazatlan handled a load of containers equivalent to 15,954 TEU –cargo roughly equivalent to 320 TEU per week. This level of business is high enough to make it attractive for new shipping companies to establish regularly scheduled container service to the port. For instance, CP Ships has recently restarted its service to Mazatlan with two ships: TMM Hidalgo and Lykes Racer. Each ship has an approximate capacity of 1,700 TEU (*Administracion Portuaria Integral de Mazatlan, 2005*).

In our view, the Port of Ensenada represents what the Port of Guaymas should aim to pursue in the short to mid term time horizon. The Port of Ensenada has a fully functional container terminal with four quay cranes. Based on conversations with personnel of Ensenada (Jauregui, 2005) we estimated that the different shipping companies providing container service to this port handle an average of 300 TEU per week. According to official SCT data (*Direccion General de Puertos*, 2005) the Port of Ensenada processed 39,202 TEU in 2004 and was expected to process over 65,000 TEU in 2005. This is roughly equivalent to 784 and 1,300 TEU per week respectively.

Table 4.1 and Table 4.2 provide a quick comparison of the three ports in terms of navigational and docking facilities (*Administracion Portuaria Integral de Mazatlan* (2005), *Administracion Portuaria Integral de Guaymas* (2005b) and *Administracion Portuaria Integral de Ensenada* (2005)).

Table 4.1 – Comparison of the Three Ports

Description	Guaymas	Mazatlan	Ensenada
Approach Channel Depth (mts)	12.3	12	12
Number Container Berths	3*	4**	2
Length, Depth of Berth 1 (mts)	177, 11	160.25, 8.5 (draft)	182.3, 10
Length, Depth of Berth 2 (mts)	200, 11	165.45, 10 (draft)	300, 15
Length, Depth of Berth 3 (mts)	177, 11	356.12, 10.5 (draft)	--
Length, Depth of Berth 4 (mts)	--	144.2, 10.0 (draft)	--

* The Port has currently 6 positions, 3 have been identified for container operations but will become 2 per the Master Plan
**These are general cargo docks

Table 4.2 – Comparison of the Three Ports in Terms of Equipment

Description	Capacity	Guaymas	Mazatlan	Ensenada
Container Quay Cranes	--	0	0	4
Container Yard Crane	35 Tons	1	--	--
Container Yard Crane	40 Tons	1	--	2
Forklifts (all)	> 45,000 lbs	--	3	4
Forklifts	35,000 lbs	--	1	--
Forklifts	30,000 lbs	--	3	--
Forklifts	20,000 lbs	--	1	--
Forklifts	15,000 lbs	6	--	4
Forklifts	< 8,000 lbs	16	--	13
Crane	20 Tons	1	--	3
Spreaders	> 45,000 lbs	0	3	--
Chassis	20 Tons	5	7	--
Chassis	40 Tons	2	--	--
Trucks	--	3	7	8
Container Shuttle (hustlers)	--	5	14	--

From the previous tables, the main differences between the ports are the equipment and the dimensions of the docking facilities. For instance, the Port of Ensenada has the advantage of having four sea-to-shore quay cranes and a depth of 15 meters in one of the docks. However, the access channel has a depth of 12 meters which limits the capacity of the vessels that the port can receive. A major shortcoming of the Port of Ensenada is that it is not serviced by rail. Thus, all the incoming containers leave the Port by truck. This is not a major shortcoming for the current operations of the port since, from our conversations with the personnel of the Port of Ensenada (Jauregui, 2005), most of the cargo passing through Ensenada has as its main origin or destination the closeby City of Tijuana, in particular the *maquiladora* industry of Tijuana. Currently, only a very small portion of the containers cross the border into the United States. Thus, the main driver behind the growth of cargo being handled in Ensenada has been the regional economy. In fact, the operator of the container terminal is using a marketing strategy focusing on the *maquiladora* industry, its high productivity and reliability (Jauregui, 2005). However, the Port of Ensenada has been able to capture some of the container cargo originating in Sonora and destined to the Far East.

The conclusion that we can draw from the previous discussion is that, apart from the availability of the quay cranes, the three ports are not very different from each other in terms of port infrastructure. The Mazatlan and Ensenada ports have been able to base their operations on the cargo generated by the regional economy and have not only been able to survive, but also, in the case of Ensenada, experience high levels of growth (*Direccion General de Puertos,* 2004). The question that needs to be asked is whether the regional economy of Sonora can support the operations of a regularly scheduled container service. While in this phase of the study we do not attempt to answer this question specifically, based on the level of development of the regions of influence of the ports of Ensenada and Mazatlan, we operate under the assumption that the answer to this question is affirmative and what remains to be determined is the level of cargo that would be sufficient to entice a steam shipping line to start a regular container service to Guaymas. We assumed that this level (400 TEU per week) should be higher than the current levels of cargo handled in either Mazatlan or Ensenada by the average shipping company. This assumption was supported from information provided by the shipping lines to Jose Luis Iberri, Director of the Port of Guaymas (Iberri, 2005). The reason for this assumption is that stopping in Guaymas represents a significant deviation from the current regularly scheduled maritime routes for container service. Table 4.3 provides the distances and navigation time from Guaymas and other ports of interest.

Table 4.3 – Distances and Time from Guaymas

	Distance (Nautical Miles)				
Port	Long Beach	Ensenada	Mazatlan	Manzanillo	Guaymas
Long Beach	0	139	1006	1206	1150
Ensenada	139	0	893	1069	1026
Mazatlan	1006	893	0	293	385
Manzanillo	1206	1069	293	0	656
Guaymas	1150	1026	385	656	0
	Time (Hours)				
Port	Long Beach	Ensenada	Mazatlan	Manzanillo	Guaymas
Long Beach	--	6 – 10	41 -- 68	49 – 81	46 – 77
Ensenada	6 -- 10	--	36 -- 60	43 – 72	42 – 69
Mazatlan	41 -- 68	36 – 60	--	12 – 20	16 – 26
Manzanillo	49 -- 81	43 – 72	12 -- 20	--	27 – 44
Guaymas	46 -- 77	42 – 69	16 -- 26	27 – 44	--

One of the important points to consider is what maritime routes to target to entice to stop in Guaymas. Some of the most common maritime routes servicing the West coast of Mexico are depicted in Figure 4.1 taken from the web site of the Port of Ensenada (http://www.puertoensenada.com.mx/principales_rutas.html).

Notice that a common practice is to service the ports of Manzanillo and Ensenada using the same route (Figure 4.1). If a shipping company were to include Guaymas in this route, between calls to Manzanillo and Ensenada, this would represent a deviation of about 613 nautical miles, or between 26 and 41 hours of additional navigational time, depending on the speed of the vessel. Thus, it is significantly different if, for instance, Mazatlan were to be included in a scheduled route, since it would imply only 117 additional nautical miles or between 5 and 8 hours of navigation. Consequently, the cargo necessary to justify a stop in Guaymas should be higher than that available in Mazatlan.

Figure 4.1 – Maritime Routes

Currently there are two shipping lines servicing the Port of Mazatlan: Mediterranean Shipping Company (MSC) and CP Ships. Based on information provided by Mexico's SCT *(Administracion Portuaria Integral de Mazatlan,* 2005) we estimated that the number of TEU for the year 2005 was slightly below 20,000. This is roughly equivalent to 400 TEU per week and 133 TEU per week per company. We also note the origin of the traffic through Mazatlan. According to official SCT data for 2004 Sonora generates about 40% of all the cargo that is exported in containers and about 11% of all the cargo that is imported in containers through the Port of Mazatlan (*Direccion General de Puertos*, 2005). Using these figures we estimate that around 2,500 of the containers handled by the port of Mazatlan in the year 2004 were generated by the state of Sonora. Since at the time of the analysis the information for 2005 was not available, we used the projection of growth of the container traffic for 2005 which was about 35% over 2004 to estimate this number of containers as 3,300 for 2005. Figure 4.2 and Figure 4.3

show the origin and destination (in percentage) of the containerized cargo moving through the Port of Mazatlan. The countries of origin for the containers moved through Mazatlan are shown in Figure 4.4.

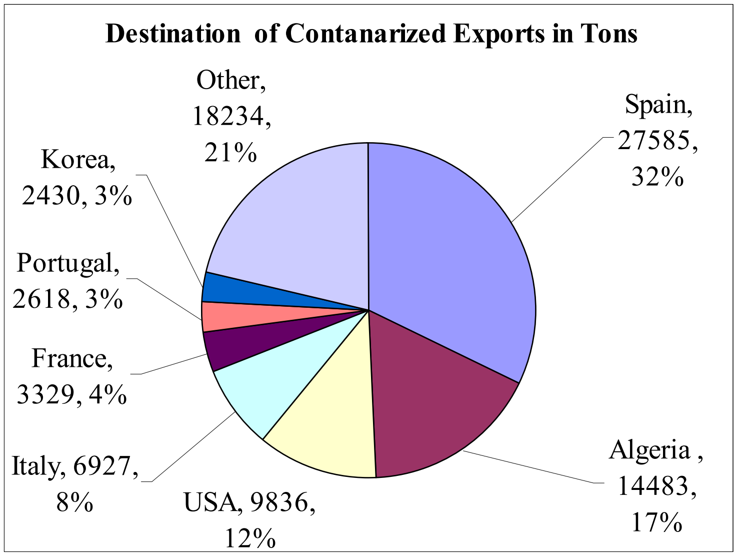

Figure 4.2 – Origin of Containers

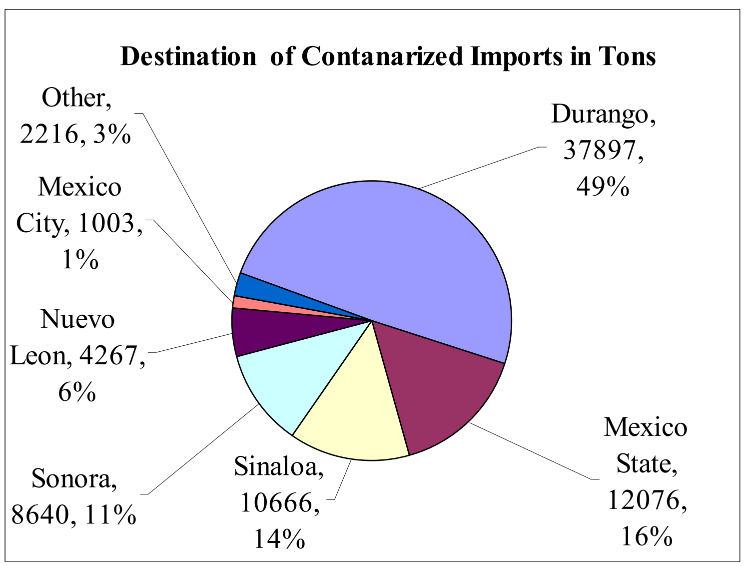

Figure 4.3 – Destination of Containers

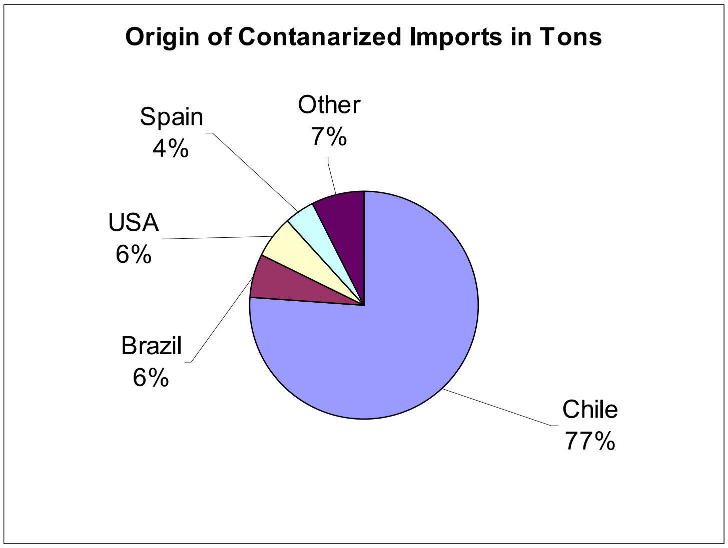

Figure 4.4 – International Origin of Containers

In terms of the Port of Ensenada, from our conversation with this port's personnel (Jauregui, 2005), we estimate that the current average TEU per week moved per steam shipping company is below 300. According to the official data provided by the SCT for 2004 (*Direccion General de Puerto*s, 2005) all the containerized cargo being imported through Ensenada has as its final destination the state of Baja California and 100% of the containerized cargo being exported from Ensenada has its origin in the states of Baja California and Sonora. From the products listed as exported in this data it is clear that Sonora is an important contributor to the cargo exported through Ensenada. A rough estimate would be that at least 10% of the containers exported from Ensenada have de State of Sonora as their origin. If we use this percentage and an approximation of 30,000 containers exported in the year 2005, we come to an estimate of around 3,000 containers per year originating in the state of Sonora.

Also, we assumed that the minimum number of containers needed to start a scheduled container service to Guaymas should be higher than that for Ensenada, hence the estimate of 400 TEU per week. This would be consistent with a baseline for a regional port. From the data above we believe that currently there are at least 160 TEU per week from Sonora that are moving through the Ports of Mazatlan and Ensenada. This number of containers is higher than our estimate of the average number of container per company being handled at the Port of Mazatlan for the year 2005. We anticipate that two of the goals to be recommended for the second phase of this project include the refinement of the estimates of the TEU generated by the zone of influence of the Port of Guaymas and discussing with the shipping lines their particular expectations and requirements to establish a regular service to and from Guaymas.

From the perspective of the railroad analysis 400 TEU represent approximately 230 containers, the mix of these containers would be 170 containers of 40' and 60 containers of 20' (this is equivalent to a 74-26% container mix, or a 85-15% TEU mix), which in turn would require a single train with around 100 well cars to transport these containers from Guaymas (Empalme) to Tucson. We assumed that each car has an average length of 65' so a full unit-train of 100 cars, plus 2-3 locomotives at around 210 feet, would have a total length of around 6,710 feet, which is a suitable length according to the current specifications of the trains operating on the corridor. This last result is assuming a mix of 33% single cars 33% three-car modules and 33% five-car modules. Therefore, the proposed baseline also corresponds to what we considered an efficient rail transportation strategy. Another observation that needs to be made is that in our proposed analysis we assume for the different scenarios that the all containers received in Guaymas would be exported to the United States.

We established a "most likely" scenario for Guaymas, after regular service is established, as roughly the same level as the number of containers being currently handled by the Port of Ensenada, or 1,200 TEU per week. In this scenario the assumption is that there are several container liners with scheduled stops at the Port of Guaymas. We believe that this scenario would be more in line with the port of Guaymas being used as a container gateway to the United States.

4.1 Summary of Baseline Analysis

We established a baseline for the analysis of the capacity of the corridor of 400 TEU per week. A second expanded baseline of 1,200 TEU per week was also established. The first scenario would represent in our estimation the most likely scenario at the start of a container service in the Port of Guaymas. The second scenario would represent expanded containers with more than one steam shipping line servicing the Port. These scenarios were set as a starting point to the capacity analysis and not as a feasibility study to attract a steam shipping line to establish a regular stop in the Port of Guaymas. Addressing this feasibility is beyond the scope of our research and is left as a logical next step in the analysis.

5 Analysis of the Port of Guaymas

Since the Port of Guaymas is an essential component of the Corridor it was the first element analyzed. The analysis consisted of the following activities:

1. Making an inventory of the current infrastructure.
2. Determining the current and maximum capacity (in TEU) of the infrastructure.
3. Identifying the services offered in the port.
4. Documenting the process map of the proposed container operations at the port.
5. Developing a simulation model to determine the capacity of the Port in terms of TEU.
6. Identifying the constraints of the Port's capacity.

Activities 1, 3 and 4 were accomplished through interviews with the Port personnel and other interested parties during visits that the research team made to the Port of Guaymas. A list of the visits and meetings is offered in Appendix G. These visits served to prepare the process maps which are included in Appendix D. These maps were used for the different analyses reported in this document. In this section of the report we first describe the current infrastructure of the port; we then make general comments on this infrastructure and the baseline infrastructure used for the analysis of the Port of Guaymas; afterwards, we broadly describe the simulation and the different scenarios used for the simulation analysis. Finally, we present the simulation analysis and conclude with a summary of the recommendations regarding the port infrastructure. Each one of these activities is briefly described next.

5.1 Inventory of the Current Infrastructure

We used four different sources of information to establish the current infrastructure of the port: direct visits to the port, information provided by the Master Plan of the Port of Guaymas (Figure 5.1), interviews with the port personnel and information available through the web site of the port (*Administracion Portuaria Integral de Guaymas*, 2005 and 2005b). We focused our attention to the infrastructure available in the port to set up a container terminal operation.

Figure 5.1– Master Plan of the Port of Guaymas

The Port of Guaymas currently has six berths in the general dock area. These positions are depicted in Figure 5.1. The dimensions in meters of the different berths are shown in Table 5.1.

Table 5.1 – Berths Dimensions

Berth	Length (mts)	Depth (mts)
1	297	3
2	200	10
3	177	10
4	200	11
5	175	13
6	175	13

The Port has identified berths 2, 3 and 4 to start the container operations. The Master Plan for the port calls for consolidating berths 2, 3 and 4 into two with a depth of 11 meters and a length of 288.5 meters each. Hence, the analysis of the capacity is based on the existence of these two berths. This implies dredging under berths 2 and 3 to get the targeted depth. A question that may be asked is whether this depth is enough to allow the operation of a container service. In order to answer this question we looked at the depth of similar ports. In particular, we use as points of comparison the ports of Mazatlan and Ensenada. This information was presented in Table 4.1. From this table we can see that the Port of Guaymas has deeper docking positions than the Port of Mazatlan and it has slightly shallower positions than the main docking position of the Port of Ensenada.

We also looked at the infrastructure available in a port that is serviced by the major container shipping lines such as the ports of Manzanillo and Colombo (Sri Lanka). Relevant information for these ports is summarized in Table 5.2. This information was taken from the web site of the Port of Manzanillo (*Administracion Portuaria Integral de Manzanillo*, 2005) and from the publication of the United Nations Conference on Trade and Development (Galhena, 2003): "Container Terminal Development and Management: The Sri Lanka Experience (1980-2002)". The information for Guaymas is based on the assumptions previously stated. The Port of Manzanillo handled over 800,000 TEU in the year 2004 and the Port of Colombo over 1,700,000 in the year 2002.

Table 5.2 – Relevant Information Summary

Description	Guaymas	Manzanillo	Colombo
Approach Channel Depth (mts)	12	16	15
Number Container Berths	2	2	4
Length and Depth of Berth 1 (mts)	289, 11	250, 14	300, 12
Length and Depth of Berth 2 (mts)	289, 11	250, 14	332, 13
Length and Depth of Berth 3 (mts)	--	--	330, 14
Length and Depth of Berth 4 (mts)	--	--	330, 14

Regarding the readiness of the Port of Guaymas to establish a container terminal, there are two main differences in terms of infrastructure between the Port of Guaymas and the ports of Ensenada and Colombo: depth of berths and navigation channels, and the availability of sea-to-shore quay cranes. In order to see what the impact of not having a shallower berth depth in the Port of Guaymas would be, we looked at the maximum draft (fully loaded) information of the ships that called on the Port of Manzanillo during the year 2005 (up to November) and then we compared this information with the depth available in Guaymas. In order to make this comparison we assumed that the maximum draft that Guaymas could handle was the depth minus one meter, or 10 meters of draft. Figure 5.3 shows the distribution of maximum draft (fully loaded) of the container ships (geared with cranes) that called in the port of Manzanillo during the first eleven months of the year 2005 (Excel sheet with arrivals provided by *Direccion General de Puertos*, 2005b). The red (left) line represents the limit in maximum draft imposed by the depth of the docking positions. The green (right) line represents the limit if the docking position were dredged to the same depth as the navigation channel. It is important to note that this limit does not necessarily apply to every ship, only when it is fully loaded.

However, to have the flexibility and be able to grow in the future we believe that a strategic analysis of the depth of the different navigational areas of the Port, and particularly in the terminal area, should be performed. This is particularly true given the current trend of every major port to dredge navigational spaces to accommodate the mega-container ships that require depths in excess of 15 meters.

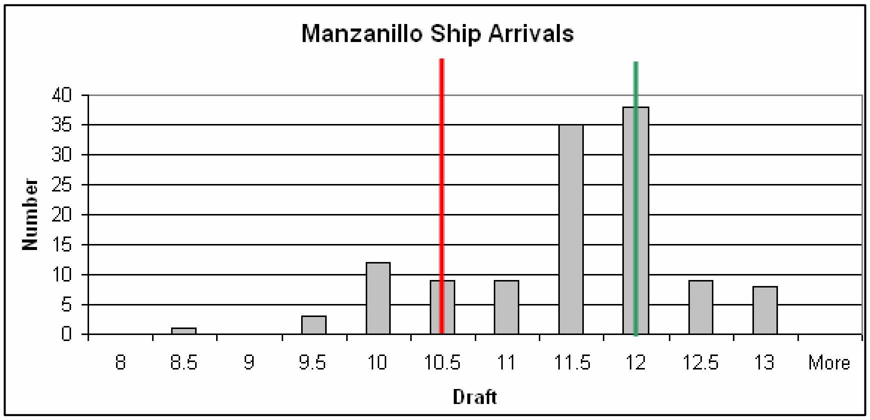

Figure 5.3 – Distribution of Maximum Draft

As a part of the activities related to the inventory of the current infrastructure, we made a physical inspection of all the areas of the Port of Guaymas and photographed the main working areas of the Port. In Figure 5.2, we present one of the proposed container yards with some of the current container handling equipment. In this image we can observe one container gantry crane and a container handling truck.


Figure 5.2 – Handling Equipment at the Port of Guaymas

5.2 The Simulation Model

The Port of Guaymas does not currently have an operating container terminal. For this reason it was not possible to take direct measurements to establish the capacity of the container terminal. In order to make an estimation of this capacity we relied on simulation models that were developed specifically to analyze the potential performance of an operating container terminal and to assess a preliminary estimation of the capacity of the Port in terms of TEU. The models are based on the ProModel® V6.0, a Montecarlo simulation package, and its aim is to obtain a valid, logical representation of the performance of the port if container service is established.

Some of the elements built into the model include: current and predicted levels of infrastructure, scheduled arrivals of container ships, internal operations of container terminal and rail and truck entry and exit processes. The characteristics built into the model are in accordance with the Master Development Plan (*Administracion Portuaria Integral de Guaymas*, 2005) prepared by the Port of Guaymas. But in order to run a more realistic simulation model, a slightly different inventory of equipment from the one currently in place in the Port of Guaymas is necessary. Table 5.3 presents a comparison between the current actual equipment inventory in the port and that assumed in the main two general scenarios considered in the simulation. For a more detailed description of the assumptions and the model, the reader is referred to Appendix I, which includes a complete report of the simulation analysis.

Table 5.3 – Infrastructure between the Current State and the Simulated Scenarios

Description	Current State	Scenario 1	Scenario 2
Container Quay Cranes	--	--	2
Container Yard Crane	2	3	3
Forklifts	22	12	12
Chassis	7	12	12
Trucks	3	7	7
Container Shuttle (Hustlers)	5	12	12
Yard Capacity in Containers	--	6552	6552

Since there was no operating container terminal on the port, we designed the potential operation of the terminal based on our review of similar ports, the UNCTAD Port Development Handbook (UNCTAD, 1985) and on interviews with operations personnel from the Port of Guaymas. The graphical interface of the simulation is presented in Figure 5.4, which shows the final design of the container terminal and its different areas.

Figure 5.4 – Screen of the Simulation Program

The main objective of the simulation was to estimate the current capacity, resource requirements (cranes, trackers, forklifts) and bottlenecks. This technique allows the generation of several scenarios with different port configurations (resource availability and capacity, arrival and service time policies) in order to evaluate different potential outcomes. Table 5.4 presents the different scenarios analyzed. The first column gives the scenario number. The second column shows the number of TEU arriving per week to the port. For this instance we used three different levels: the baseline or 400 TEU per week; an expanded scenario of 1,200 weekly TEU; and a third scenario of 2,000 TEU per week as the upper limit of the current capacity of the port –this is roughly 175,000 TEU per year. This third scenario was set by observing the utilization of the Port's equipment under increased demands. We believe that this capacity represents a conservative scenario for the current conditions of the Port, which may review upwards once the exact container terminal configuration is determined and analyzed.

The third and fourth columns give the total number of incoming and outgoing containers passing though the port. In order to arrive at the numbers shown in this column we made assumptions of empty containers for exportation being 70% of the loaded containers arriving to the port; and a particular mix between two sizes of containers 40’ (74%) and 20’ (26%). The fifth and six columns give the mix of containers (in percentage) leaving the Port of Guaymas by truck and train. The next column is the total number of yard cranes assumed by the simulation. In this case we assumed three cranes for the container yard operation which is one more than what was available when we did the infrastructure inventory of the port. Next column represents the number of quay cranes considered in the simulation –having used two levels: zero and two cranes. The former number represents the current level and the latter represent the level we believe will make the port feasible, in terms of ship turnaround times, for attracting shipping lines. Gearing the Port with these cranes, however, represent the single main investment on the Port considered in this analysis. Column nine represents the number of onboard cranes used by a ship to load and unload containers when a quay crane is not available. Columns 10 thru 15 show the rest of the equipment infrastructure considered in each of the scenarios. This infrastructure is the same or slightly higher than what is currently available at the port.

Table 5.4 – Scenarios Analyzed for the Operation of the Port of Guaymas

		Containers/Week		Ship Method									
Cases	TEU	Full	Empty	Truck %	Train %	Hustler	Hustler FC	Yard Crane	Quay Crane	Ship Crane	Forklift	Module	Tug
1	400	230	168	0	100	12	8	3	0	2	12	15	2
2	400	230	168	100	0	12	8	3	0	2	12	15	2
3	400	230	168	50	50	12	8	3	0	2	12	15	2
4	400	230	168	30	70	12	8	3	0	2	12	15	2
5	400	230	168	70	30	12	8	3	0	2	12	15	2
6	1200	690	480	0	100	12	8	3	0	2	12	15	2
7	1200	690	480	100	0	12	8	3	0	2	12	15	2
8	1200	690	480	50	50	12	8	3	0	2	12	15	2
9	1200	690	480	30	70	12	8	3	0	2	12	15	2
10	1200	690	480	70	30	12	8	3	0	2	12	15	2
11	400	230	168	0	100	12	8	3	2	0	12	15	2
12	400	230	168	100	0	12	8	3	2	0	12	15	2
13	400	230	168	50	50	12	8	3	2	0	12	15	2
14	400	230	168	70	30	12	8	3	2	0	12	15	2
15	400	230	168	30	70	12	8	3	2	0	12	15	2
16	1200	690	480	0	100	12	8	3	2	0	12	15	2
17	1200	690	480	100	0	12	8	3	2	0	12	15	2
18	1200	690	480	50	50	12	8	3	2	0	12	15	2
19	1200	690	480	70	30	12	8	3	2	0	12	15	2
20	1200	690	480	30	70	12	8	3	2	0	12	15	2
21	2000	1150	800	50	50	12	8	3	0	2	12	15	2
22	2000	1150	800	50	50	12	8	3	2	0	12	15	2

Table 5.5 – Results for the Scenarios Analyzed for the Operation of the Port

		Containers/Week		Ship Method										
Cases	TEU	Full	Empty	Truck (%)	Train (%)	T/A Vessel	Time in Dock	Time Rail	Time Truck	# Cont Rail	# Cont Truck	# Cont Yard	Dock Util	Max Yard
1	400	230	168	0	100	27.12	25.62	32.32	--	24112.7	--	123.18	0.15	384
2	400	230	168	100	0	27.05	25.55	--	11.09	--	24109	92.52	0.15	311
3	400	230	168	50	50	27.1	25.6	30.27	11.14	11878.4	12233	106.39	0.15	314
4	400	230	168	30	70	27.05	25.56	29.03	12.04	16656.8	7429	110.91	0.15	328
5	400	230	168	70	30	27.05	25.55	37.03	11.09	7112	16987	103.42	0.15	314
6	1200	690	480	0	100	26.02	25.25	33.32	--	71881.6	--	192.83	0.45	391
7	1200	690	480	100	0	26.01	25.23	--	11.09	--	718812	99.57	0.45	315
8	1200	690	480	50	50	26.03	25.25	26.71	11.18	35579.2	36353	132.49	0.45	319
9	1200	690	480	30	70	26.02	25.25	28.43	12.58	49844	22073	152.22	0.45	337
10	1200	690	480	70	30	26.03	25.25	28.89	11.11	21327.2	50619	121.77	0.45	309
11	400	230	168	0	100	12.17	10.82	32.3	--	24100.8	--	125.72	0.06	466
12	400	230	168	100	0	12.16	10.8	--	7.12	--	24115	90.1	0.06	436
13	400	230	168	50	50	12.2	10.83	26.56	7.07	11916.8	12213	104.33	0.06	445
14	400	230	168	70	30	12.2	10.84	32.63	7.16	7150.4	16981	101.72	0.06	450
15	400	230	168	30	70	12.2	10.84	29.48	6.97	16734.4	7403	112.59	0.06	454
16	1200	690	480	0	100	11.48	10.75	31.44	--	71856.8	--	201.16	0.19	474
17	1200	690	480	100	0	11.46	10.73	--	7.11	--	71855	98.77	0.19	446
18	1200	690	480	50	50	11.48	10.74	23.94	7.07	35636.8	36296	134.35	0.19	449
19	1200	690	480	70	30	11.48	10.75	25.29	7.17	21276.8	50617	122.12	0.19	445
20	1200	690	480	30	70	11.48	10.75	27.04	6.97	49760	22187	157.2	0.19	461
21	2000	1150	800	50	50	24.3	23.7	25.1	11.23	70980	72624	160.83	0.83	311
22	2000	1150	800	50	50	10.71	10.14	23.01	7.09	71068	72628	168.89	0.35	436

The results corresponding to each of the previous scenarios are shown in Table 5.5. The first six columns of this table give the scenario information. The column 7 gives the ship turnaround time in hours. This is the time it takes for a ship to be serviced by the Port of Guaymas from the time it arrives to the outside stopping buoy to the time it leaves the port. The eighth column gives the time in hours the ship was docked in the port. Columns nine and ten represent the time a container takes to leave the port in hours from the time it arrives to the port to the times it leaves the port by either train or truck. The next two columns, 11 and 12: show the number of loaded containers leaving the port by train or truck in a simulated period of two years. Column thirteen gives the average number of containers in the container yard during the simulated period. The fourteenth column gives the average utilization for berth three. In this case it is important to highlight that berth four (second container berth) was never used in the simulation. The last column gives the maximum utilization (in containers) of the container yard. It was assumed that the port worked a schedule of 24 hours/7 days a week and it was assumed that the ships were uniformly spaced during the week and each ship carried an average of 400 TEU. Some of the results that can be derived from the simulation study include:

1. There is a significant difference between the turnaround times for the scenarios of the Post operating with and without quay cranes. This difference is of about 14 hours. The average time without quay cranes is of about 26.34 hours and 11.73 for the scenarios with quay cranes (see Figure 5.5 and Figure 5.6). This is consistent with the turnaround time reported by the Port of Manzanillo for similar scenarios (See Appendix I).

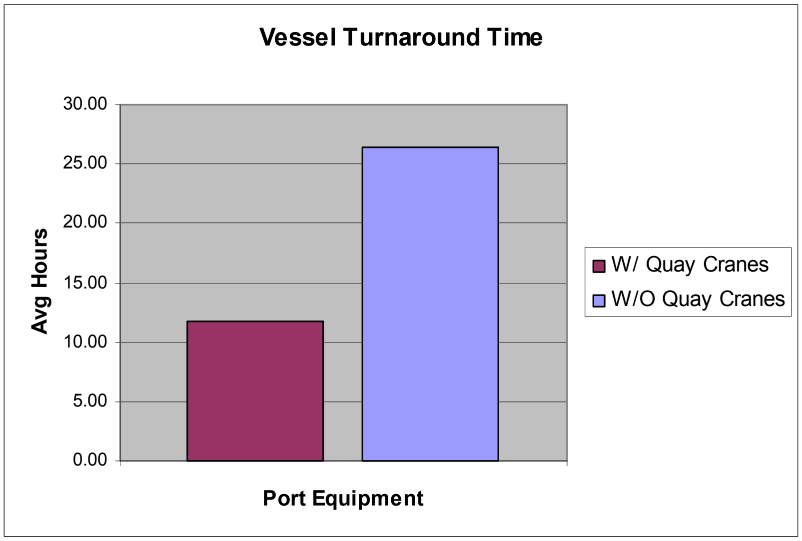

Figure 5.5 – Vessel Turnaround Time

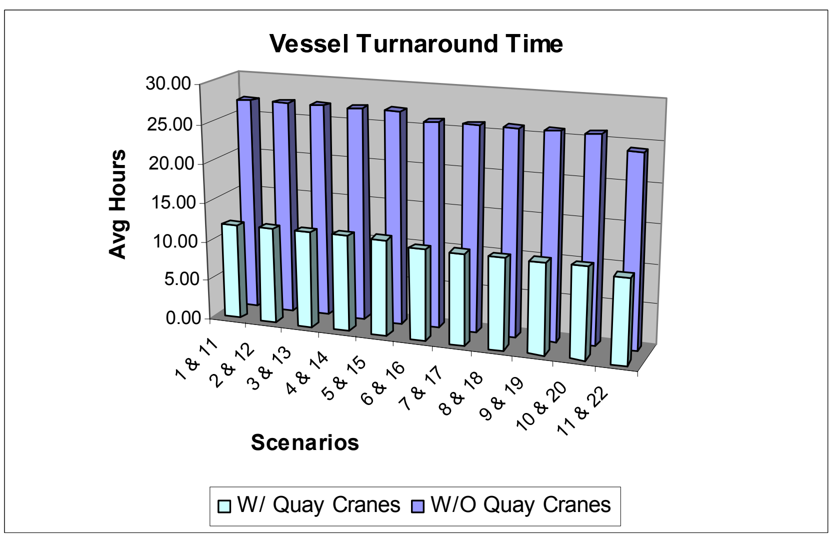

Figure 5.6 – Vessel Turnaround Time

2. The capacity of the container yard did not represent a constraint under the simulated conditions. However, an assumption was made that the containers would leave the

container yard as soon as truck or rail transportation was available. This is consistent with a transshipment (or export) operation, but overly optimistic for a domestic operation.

3. Under the simulated conditions the docking facility does not seem to be a major constraint for the capacity of the port. However, it was observed that the utilization for one of berths, at the maximum level of demand, approached 85% when the cranes of the ship were used to unload/load containers. This is in contrast with the 35% reported when quay cranes are used. Something that needs to be mentioned is that the simulation used only one of the berths available. On the surface, this would seem to imply that the capacity reported (175,000 TEU) would be obtained with only one berthing position. However, we can not make this claim because the simulation was based on the assumption that six ships per week would visit the port in a time-uniform basis. This is hardly the case in real-life situation. Thus, the capacity number reported should be read as being based on the availability of two berthing position. A higher resolution simulation could be used to refine the capacity estimate.

4. Although the simulation was not run to the limit of the capacity of the port, we can draw the inference that the crane (or the lack thereof) factor was the main determinant of the capacity of the operation of the container terminal.

5. The maximum capacity analyzed was based on similar operations. We believe that this capacity (around 175,000 TEU) represents a lower limit of the capacity of the port rather than a hard upper limit. However, with the information available at the time of the study it was the number with which we felt comfortable. A more precise study could provide a revised capacity of the Port of Guaymas.

From the perspective of the time needed to for a container to leave the port, once it is unloaded, we can see that the truck option is more efficient (see Figure 5.7 and Figure 5.8). However, this alternative could be significantly more expensive than the rail alternative.

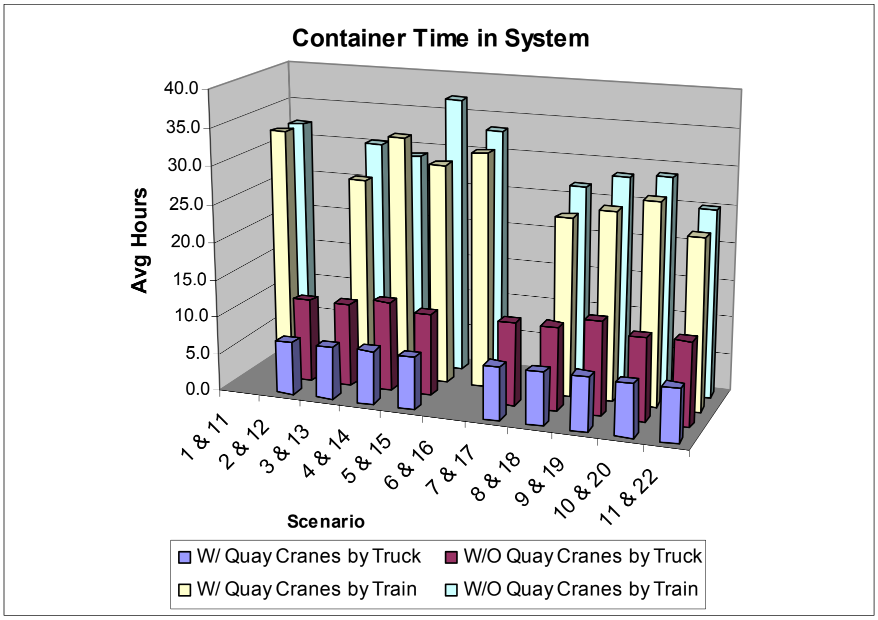

Figure 5.7 – Container Time in System

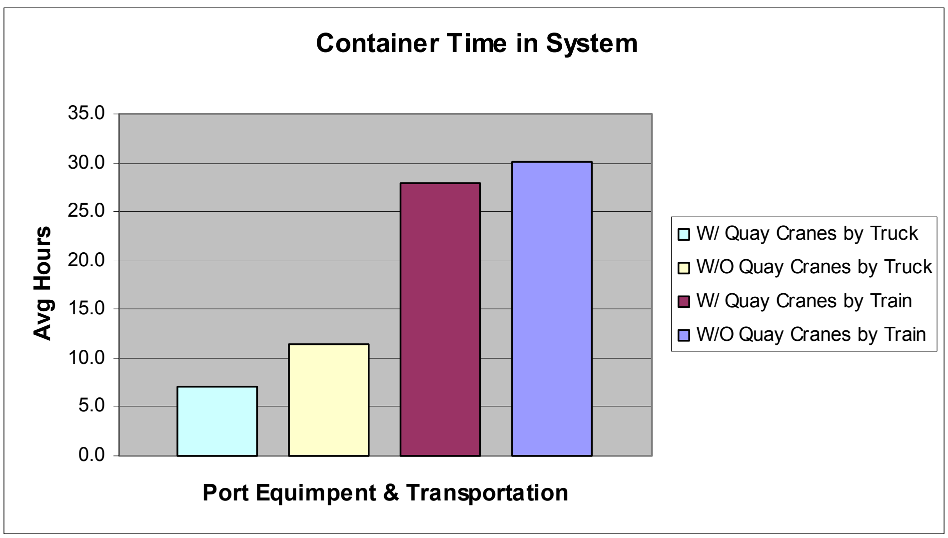

Figure 5.8 – Container Time in System

In order to verify and validate the simulation model we followed two approaches: verifying with experts and comparing the results of the simulation with operations of similar characteristics. After the first version of the simulation for the Port of Guaymas was finished we invited the operations personnel of this port to review the simulation and the assumptions included in the model. From this review the personnel from the port agreed on the general validity of the assumptions and we made some minor adjustments to the model.

In order to further validate the simulation model we compare the performance measures given by the simulation to data available for container operations for the Port of Manzanillo. We made the comparison for the operations based on the turnaround times of the container ships for the cases where the cranes of the ships were used to unload and load containers and also for the cases for which quay cranes had been used (See Appendix I). The results obtained supported the validity of the simulation model. Although we believe that the current simulation model reflects the general operation of a container terminal, we also believe that this simulation model can be significantly improved by having access to higher-resolution operational data. For instance, some of the parameters are based on historical averages rather than precise time distributions. The availability of this data would render a more precise simulation model.

5.3 Summary of the Infrastructure of the Port of Guaymas

From an infrastructure perspective, we believe that the port of Guaymas, with some minor improvements, such as the acquisition of additional container handling yard equipment, is ready to start a container service comparable to that of the Port of Mazatlan; that is, a regional container service.

However, the current main limitation of the port capacity is the current unavailability of quay cranes. This precludes the Port of Guaymas from being able to offer efficient turnaround services to the modern container ships that are not geared with their own cranes. This in turn may limit the potential of the Port of Guaymas to serve as an efficient gateway port for container service beyond the local region. In order to provide this service we believe that at least two quay cranes are needed. The exact capacity and characteristics of the quay cranes and related issues, such as the need for reinforcement of the piloting system of the port is beyond the scope of this study.

In our analysis, we have made assumptions about the type of infrastructure and level of service needed to attract a shipping line to establish a port of call by a major container shipping line. However, the exact needs, in terms of service and demand, should be explored with the shipping companies. We also assumed that the operational performance of the Port and the authorities was efficient, but this is hardly the case in the operation of other Mexican ports (Peyrelonge et al., 2003), so we also advise to consider additional research into the efficient operations of all the activities involved in importing and exporting the cargo in the Port. Both of these issues are left as future research.

6 Analysis of the Mariposa Port of Entry

The main purpose of the analysis of the Mariposa Port of Entry (POE) was to determine the impact that the operation of a container terminal in Guaymas would have on the operations of the port. Some of the measures of performance selected to assess this impact included: average time of trucks to clear inspection and operational hours of Mariposa to clear the demand.

The analysis of the POE was divided into the following activities:

1. Documenting the process map of the container processing operations.
2. Developing a simulation model to estimate: capacity, bottlenecks, and cycle times.
3. Obtaining information on projected demands and flows.
4. Identifying bottlenecks in the operations.

As shown in Figure 6.1, the information obtained from the Port of Guaymas simulation model was used as input in the Mariposa POE simulation model to obtain the desired results. A brief description of the process map and the simulation model developed follow.

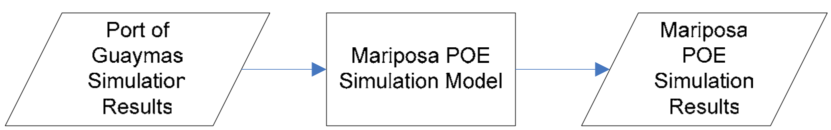

Figure 6.1 – Mariposa POE Simulation Input

The Mariposa Port of Entry is the name given to the inspection compound which every commercial vehicle entering the United States (US) must go through if crossing at the city of Nogales. When a truck enters the inspection process, it can be released automatically or requested to go through different inspection stations before being authorized to cross from the port to the US.
The whole system can be divided into four different sections:

1. **Pre-Screening and Primary Inspection:** These are the first two steps in the process and all trucks go through them.
2. **Secondary Inspection:** Different tasks can be done in this section: normal secondary inspection, 100% inspection (unloading all the cargo), weapons and enforcement inspection, and others.

3. **X-Ray:** There are two stations for X-Ray inspection.
4. **ADOT Compound**: ADOT's Motor Vehicle Division safety inspection and other Federal inspections are conducted here.

The flow diagram in Figure 6.2 shows the logic followed by trucks in the simulation. For more detailed information about the Mariposa POE Process see Appendix D.

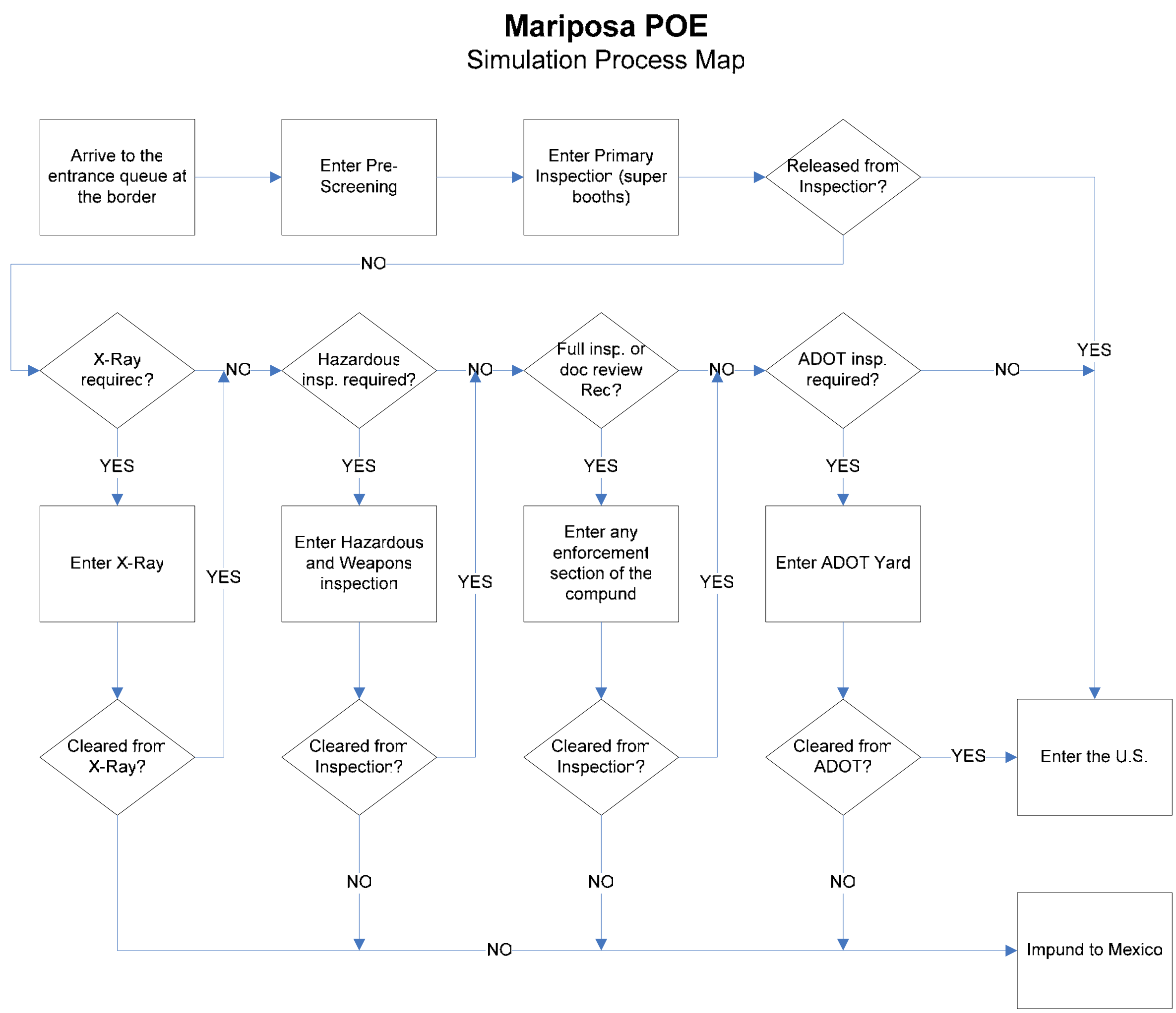

Figure 6.2 – Mariposa POE Simulation Process Map

While the trucks move through all the different individually required steps of the inspection process, several institutions work together. A partial list includes:

1. Customs and Border Protection (CBP)
2. United States Department of Agriculture (USDA)
3. Food and Drug Administration (FDA)

4. Arizona Department of Transportation (ADOT)
5. Federal Motor Carrier Safety Administration (FMCSA)

The physical movement of the trucks is simple and can be observed in the animation of the simulation (Figure 6.3 shows an image of the simulation interface and the different stations). Currently: [1] trucks cross the border in two lanes, [2] enter one of the two pre-screening stations, [3] follow to one of the four primary inspection super-booths, and then proceed to Nogales, Arizona (AZ) or remain in the compound for further inspection always driving in a Counter Clock Wise (CCW) motion around the compound [4, 5, 6 & 7]. These rules are adjusted as the team at Mariposa attempts to be more efficient and to react to demand changes.

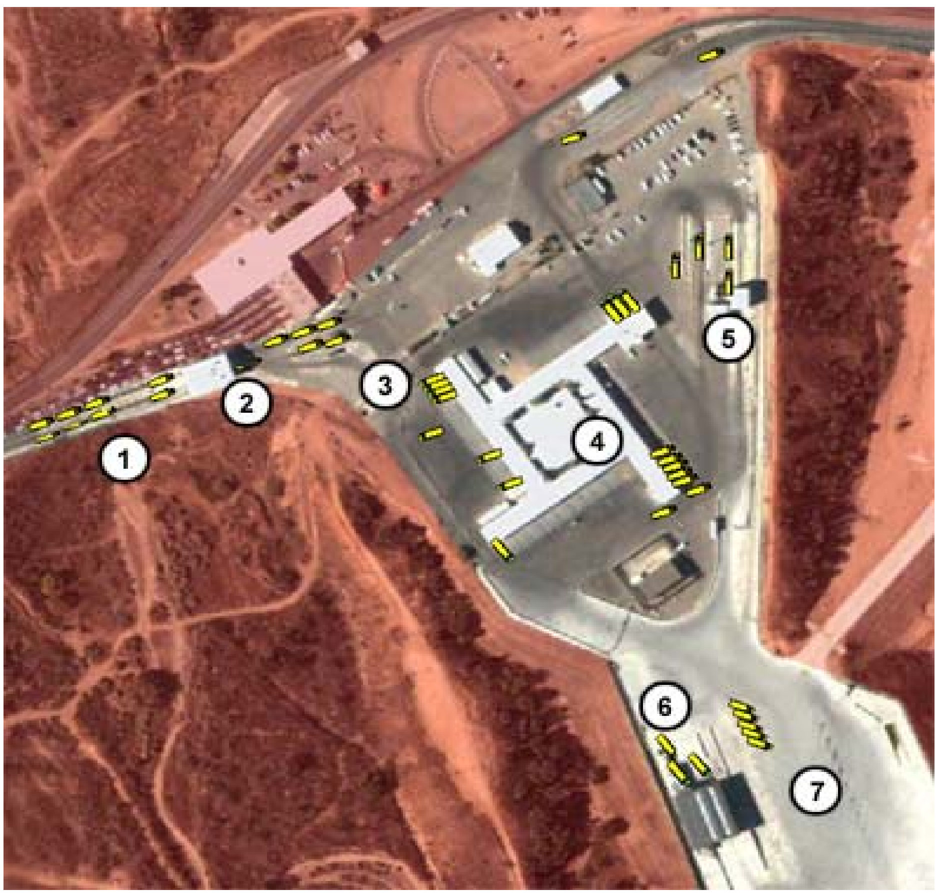

Figure 6.3 – Graphical Interface of the Simulation Program for the Mariposa POE

In order to determine the impact on the Mariposa POE of a container terminal in the Port of Guaymas different scenarios were run using simulation models. After defining the different scenarios to be analyzed and obtaining results from the Port of Guaymas simulation, the obtained information was used to make an assessment of the Mariposa POE capacity, and the impact of the containerized cargo moving by highway on the POE. The information used for each scenario is shown in Table 6.1. The first column gives the scenario number (in accordance with the scenarios ran in the Port of Guaymas simulation shown in Table 5.4). The second column shows the TEU per week expected to pass through Guaymas. On the third column the number of actual containers to be moved weekly by the Port of Guaymas is presented. In the fourth and fifth column the distribution percentage assumed for containers being moved by truck and by rail is shown. The sixth column shows a current high season demand assumed to analyze the different scenarios; this number was fixed based on historic data and current demand in the port of entry. The extra demand expected daily from the Guaymas' port operation is shown in the seventh column and the total number of containers to cross the Mariposa POE is shown in the last column.

Table 6.1 – Information Used for Each Scenario for the Mariposa POE

Cases	TEU	Containers	Truck %	Rail %	Current Demand	Qty Exit Port	Extra Demand	Rate (min)	Total Demand
Current	--	--	--	--	1300	0	0	0	1300
1	400	230	0	100	--	--	--	--	-
2	400	230	100	0	1300	230	154	3.9	1454
3	400	230	50	50	1300	108	76	7.93	1376
4	400	230	30	70	1300	72	42	14.5	1342
5	400	230	70	30	1300	50	50	5.5	1350
6	1200	690	0	100	--	--	--	--	-
7	1200	690	100	0	1300	233	154	3.9	1454
8	1200	690	50	50	1300	128	73	8.3	1373
9	1200	690	30	70	1300	74	38	16.07	1338
10	1200	690	70	30	1300	164	110	5.49	1410
11	400	230	0	100	--	--	--	--	-
12	400	230	100	0	1300	239	239	1.99	1539
13	400	230	50	50	1300	113	113	3.55	1413
14	400	230	70	30	1300	157	157	2.8	1457
15	400	230	30	70	1300	76	76	6.47	1376
16	1200	690	0	100	--	--	--	--	-
17	1200	690	100	0	1300	233	233	1.97	1533
18	1200	690	50	50	1300	112	112	3.57	1412
19	1200	690	70	30	1300	169	169	2.8	1469
20	1200	690	30	70	1300	68	68	5.85	1368
21	2000	1150	50	50	1300	105	77	7.83	1377
22	2000	1150	50	50	1300	112	112	3.82	1412
Max	--	--	--	--	2000	0	0	0	2000

The results of running the simulation of the POE in the previously described scenarios are shown in Table 6.2. The first four columns show the scenario conditions. The sixth column shows the expected average time in the system of each truck moving through Mariposa. In the seventh column, the total amount of minutes required to process the demand of any given day is shown. The extra hours required (against the current working time) to clear the compound with the increased activity is shown in the eighth column. The ninth column is the highest observation of trucks in queue to enter the compound. On the tenth and eleventh columns show the bottleneck of the system and its utilization for the simulation study. Finally, in column twelve the nominal utilization of the POE (total demand divided by total capacity) is estimated based on the 1,500 trucks/day capacity stated by Mariposa's personnel.

Table 6.2 – Results of Running the Simulation of the POE

Cases	TEU	TEU Per Year	Truck (%)	Total Demand (truck)	Truck Time In System	Operation Time (minutes)	Extra Hours	Max in Queue (trucks)	Bottle-neck	Reported Util.	POE Util.
Current	-	-	-	1300	45.22	764.22	1.74	163	PSA	75.69%	86.67%
1	400	20,800	0 %	-	-	-	-	-	-	-	-
2	400	20,800	100 %	1454	75.34	830.82	2.85	278	PSA	75.64%	96.93%
3	400	20,800	50 %	1376	57.97	830.45	2.84	265	PSA	73.27%	91.73%
4	400	20,800	30 %	1342	50.01	820.36	2.67	217	PSA	72.49%	89.47%
5	400	20,800	70 %	1350	61.1	808.24	2.47	202	PSA	74.69%	90.00%
6	1200	62,400	0 %	-	-	-	-	-	-	-	-
7	1200	62,400	100 %	1454	75.34	830.82	2.85	278	PSA	75.64%	96.93%
8	1200	62,400	50 %	1373	63.54	838.7	2.98	238	PSA	72.93%	91.53%
9	1200	62,400	30 %	1338	57.46	840.94	3.02	202	PSA	70.70%	89.20%
10	1200	62,400	70 %	1410	68.64	851.05	3.18	259	PSA	73.83%	94.00%
11	400	20,800	0 %	-	-	-	-	-	-	-	-
12	400	20,800	100 %	1539	101.41	897.18	3.95	401	PSA	76.65%	102.60%
13	400	20,800	50 %	1413	76.94	856.84	3.28	294	PSA	73.49%	94.20%
14	400	20,800	70 %	1457	80.91	835.51	2.93	280	PSA	78.05%	97.13%
15	400	20,800	30 %	1376	58.21	844.87	3.08	191	PSA	72.61%	91.73%
16	1200	62,400	0 %	-	-	-	-	-	-	-	-
17	1200	62,400	100 %	1533	96.14	881.52	3.69	355	PSA	76.98%	102.20%
18	1200	62,400	50 %	1412	72.13	854.13	3.24	271	PSA	73.75%	94.13%
19	1200	62,400	70 %	1469	84.8	874.52	3.58	309	PSA	74.65%	97.93%
20	1200	62,400	30 %	1368	62.83	831.53	2.86	200	PSA	73.88%	91.20%
21	2000	104,000	50 %	1377	58.44	841.42	3.02	203	PSA	73.06%	91.80%
22	2000	104,000	50 %	1412	75.06	839.8	3.00	246	PSA	76.26%	94.13%
Max	-	-	-	2000	197.91	1,139.78	8.00	835	PSA	78.41%	133.33%

Some of the results that can be derived from the simulation include the following:

1. The expected average time for each truck to go through the port of entry will increase from a current 45.67 ± 6.03 minutes delay to a 101.86 ± 9.63 minutes expected worst

case scenario delay –when 239 (in average) containers leave the port of Guaymas in a single day at a rate enough to reach the border the same day (See Appendix H for details).

2. The impact of having quay cranes operating at the port of Guaymas –and the increased rate and number of trucks going to Mariposa; will impact the average waiting time per truck from a 63.10 minutes wait to cross the border (no quay cranes) to a 79.71 minutes (see Figure 6.4).

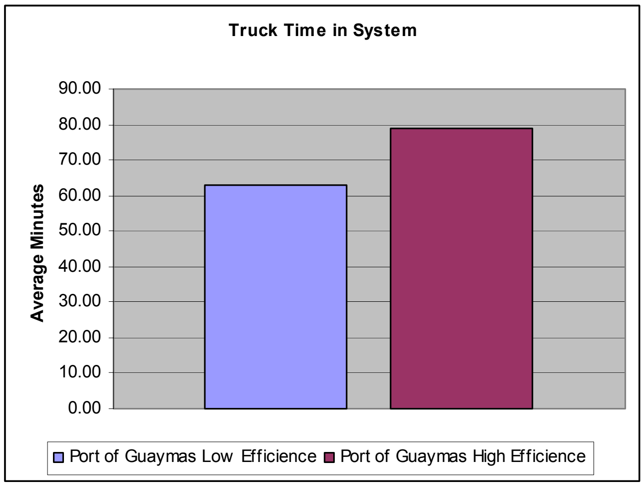

Figure 6.4 – Average Truck Time in System

3. The only case with marginal difference in inspection times was the Max scenario in which the waiting time increased to 198.36 ± 9.50 (see Figure 6.5). As it was advised by the personnel at Mariposa, demand over 1'500 trucks/day would be considered over capacity and have an impact in the waiting times.

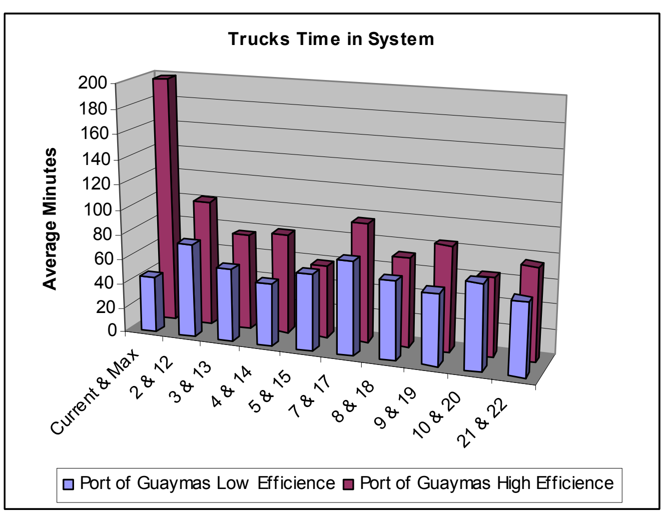

Figure 6.5 – Average Trucks Time in System per Scenario

4. The processing of the additional demand could require up to 2.2 additional hours of operation of the POE personnel (see Figure 6.6). Based on current information from Mariposa, we know that to process a daily demand of 1,300 trucks an additional 1.5 hours should be worked over regular schedule –to finish around 8:30 pm. We can estimate that under current operation conditions, i.e., same facilities and personnel; it could be required for the POE to work almost 4 extra hours (11 pm) to clear the demand in a worst case scenario –when 239 (in average) containers leave the port of Guaymas in a single day at a rate enough to reach the border the same day.

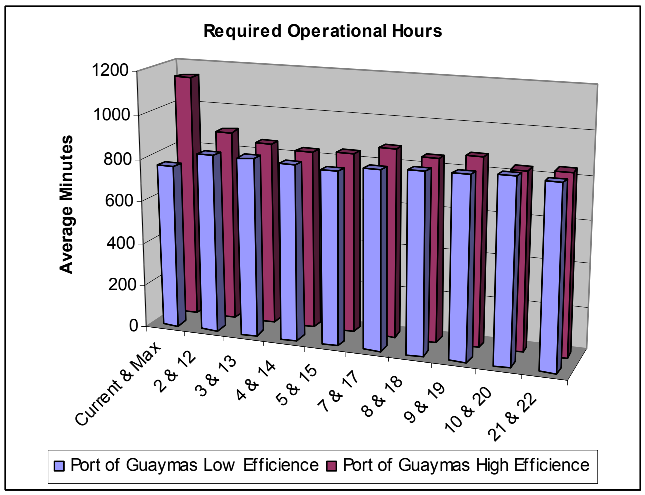

Figure 6.6 – Required Operational Hours to Clear Compound

5. The bottleneck of the system is the pre-screening station and this will be the first to require an upgrade in order to be more efficient.

In order to verify and validate the model we used some common techniques for simulation. Information regarding the inspection process was utilized to build a logic flow. A first visit to the POE served to collect current information on the system performance. After a preliminary model was developed, a meeting with personnel of Custom Border Protection (CBP) and ADOT helped to validate the current flow of trucks in the compound. With the purpose of having accurate results of the processing times, our staff joined CBP personnel for a validation session. The feedback we received is included in the results of this report.

It is important to mention that our capacity analysis is based on the current infrastructure in place. CBP is about to implement (see letter from Donna de la Torre in Appendix J) some programs, such as Fastlane and E-Manifest, that should have a positive impact on the currently installed capacity of the Mariposa Port of Entry. The exact impact of these programs is something that should be analyzed in the future.

6.1 Summary of the Analysis

According to the analysis performed to the operation of the Mariposa POE, its current utilization is already high (over 85%) during the peak time of the year. This means that any additional traffic to the port can have a significant impact on the operations of itself if it is not managed appropriately. In our analysis we made the assumption that the hours of operation of the port would be flexible to accommodate the additional traffic. If this is the case, the impact from the operation of a container terminal in the Port of Guaymas goes from negligible –for the most likely scenario; to considerable when: 1) 100% of the containers from the Port of Guaymas move by highway, 2) a demand based on the peak season of the operation of the POE is assumed, and 3) the Port of Guaymas is operating with two quay cranes. It must be noticed that the maximum amount of trucks that can be processed daily at Mariposa POE under current operation conditions is around 1,500 trucks. Considering a current demand of up to 1,300 per day: it can only serve 200 trucks extra per day approximately –or only 104,000 TEU (see Table 9.3) extra per year; without significantly affecting the waiting times currently observed. It's fair to mention that the results obtained are based on the assumption that the demand is that one observed during the peak of the produce season in Mexico (which corresponds to winter months).

7 Analysis of Highway Infrastructure Supporting the Port of Guaymas

The analysis of the highway infrastructure was divided into the following activities:

1. Identification of the main highways of the Corridor.
2. Identification of highway network in terms of links and nodes.
3. Developing the appropriate models for the analysis of the highway network.
4. Determination of current state of the highway network and the effects of added traffic caused by the operation of a container service in the Port of Guaymas.
5. Estimation of the capacity and its utilization in each of the components of the network.
6. Identification of the bottleneck points.

In terms of highways, in the Mexican side we focused on the Federal Highway 15, which is the main transportation link between the Port of Guaymas and Nogales (Sonora) and the main transportation link between Sonora and Arizona (Wilbur Smith Associates, 2001). On the US side of the border we focused on the Highway I-19 that connects the City of Nogales (AZ) with the City of Tucson. In Figure 7.1 we present a Geographic Information Systems (GIS) map that contains the visual information of the main highways being studied. For a detailed description of the roads included in the study the reader is referred to Appendix E of this report.

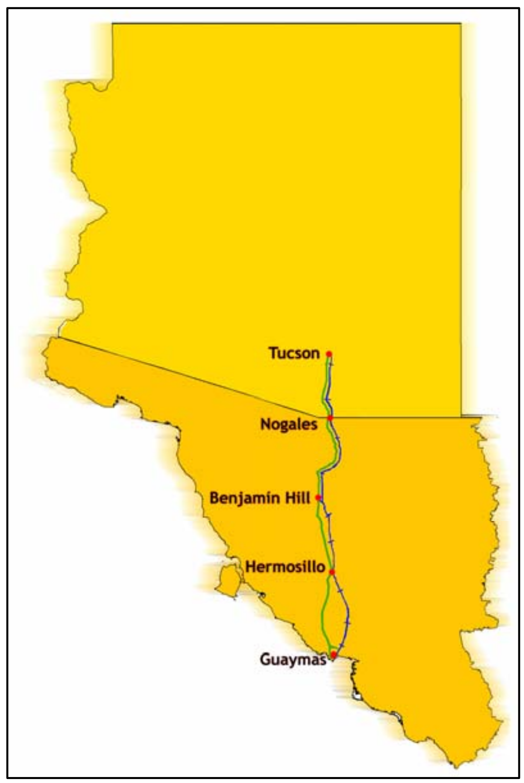

Figure 7.1 – GIS Map of the Corridor under Study

As part of the analysis we divided the highway infrastructure into nodes and links (or segments). We defined links as segments of the highway that have similar characteristics in terms of infrastructure, such as lanes, cargo capacity, clearance, and so forth. Nodes were defined as places where transfers between modes can occur or where the performance conditions are different, such as in populated places, toll booths or ports of entry (see Appendix E). The idea behind this approach is to determine the capacity and utilization in each one of the links and nodes in order to identify the bottleneck of the network. The cities of Tucson and Hermosillo, the Mariposa Port of Entry in Nogales, and the Port of Guaymas were identified as the main nodes in the highway network (see Appendix E).

Because of their complexity, it was necessary to develop Montecarlo simulation models for the analysis of the Port of Guaymas and the Mariposa Port of Entry. The results of these analyses are presented in Sections 5 and 6 of this report. The capacity analysis of the rest of the links and nodes of the highway network is presented next.

The capacity of the other nodes and links in the system was calculated analytically based on estimates of current conditions of these nodes. For these calculations we followed the recommendations and data provided by the Highway Performance Monitoring system (HPMS) (Arizona Department of Transportation ADOT, 2005a), the Highway Capacity Manual (HCM) (Transportation Research Board, 1994), the Multimodal Corridor and the Capacity Analysis Manual (MCCAM) (Cambridge Systematics Inc., 1998). The volume and estimated capacity are expressed in passenger cars per hour (PCPH) and capacity utilization. The data used for the flow (volume) of vehicles, was registered by permanent stations located at different segments of the road. The data was obtained from official data reports from ADOT and SCT (ADOT 2005b, 2005c and SCT 2005). The exact methodology used to arrive at the different capacity estimations is presented in Appendix F.

The capacity for the highway segments were estimated based on the HPMS methodology, which is a standard methodology (ADOT, 2005a) to estimate the capacity of the highways for the State of Arizona. The capacity results for the highway links in the State of Arizona can be observed in Figure 7.2. Where the level of service (LOS) is a measure of the current utilization of the capacity of the highways (volume/capacity). Thus, the highways that are at capacity or near capacity have a LOS (.90 – 1.0 utilization). This is the case for the segment of the Interstate-19 (I-19) that connects with the I-10 in the City of Tucson. This LOS indicates that at certain periods of the day there is significant congestion on this highway, which might create delays and queues for vehicles traveling at those periods of the day. Other than the city of Tucson, the rest of the highway in Arizona seems to have enough capacity for the volume of vehicles they currently handle.

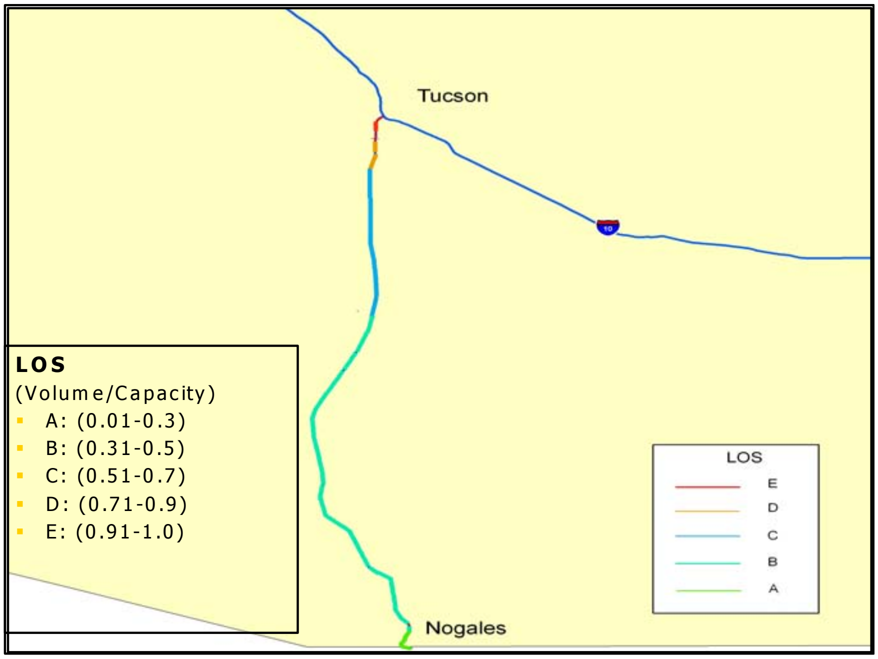

Figure 7.2 – Highway Capacity in Arizona

The results for the Mexican highway are presented in Figure 7.3, and shows that there is not a significant point of congestion along the Mexican highway linking Guaymas and Nogales, Sonora. The road segment with the lowest remaining capacity and with highest utilization (0.28) is located in the highway segment linking the Port of Guaymas to the town of Empalme where the highway is reduced to a two-lane rural road. There is an alternative, more direct, route linking the Port of Guaymas to Highway 15 that goes though the City of Guaymas. However, this route was not considered in the analysis because we felt that this route was not likely to be used by the container-carrying traffic from the Port of Guaymas.

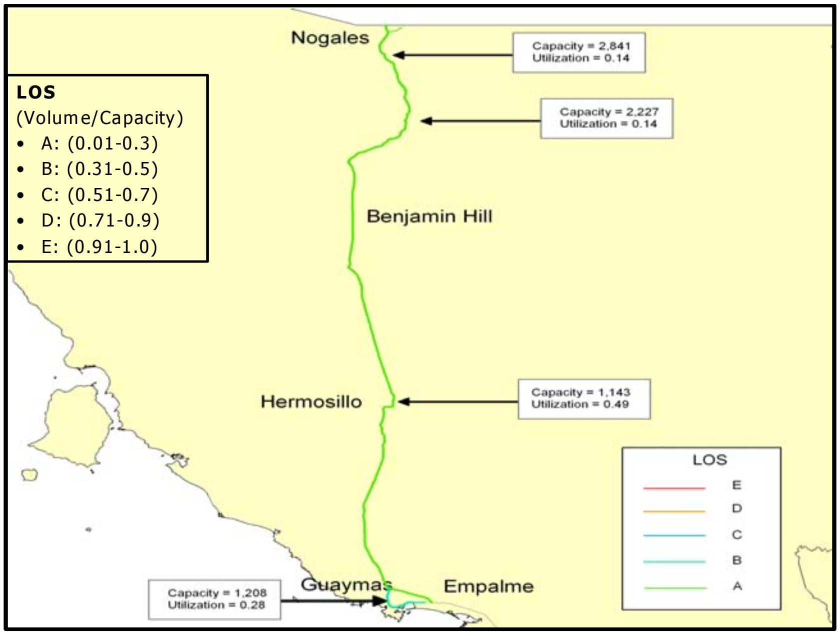

Figure 7.3 – Highway Capacity in Sonora

For the Mexican Highway, we encountered that HPMS information was not readily available, so we had to calculate the capacity using the information provided by the *Instituto Mexicano del Transporte* (Bello *et al*., 2001) for the Mexican roads. We followed the same methodology used in Arizona and we also consistently used the information provided in the Highway Capacity Manual (2000). In order to obtain some of the information needed for our analysis, related to the physical characteristics of the highway, we had to physically inspect the highway (See for instance Figure 7.4). For a detailed description of the methodology the reader is referred to Appendix F.

Figure 7.4 – Mexican Highway Inspection

Another potential point of congestion is located at the City of Hermosillo along the route used by heavy vehicles to traverse the city. This segment of the road is constrained by traffic lights and speed bumps, increasing the utilization of this segment of the road to 0.49 (See Table 7.1). In order to arrive to this utilization, since no actual traffic recording for this precise route was available, we used the maximum flow of vehicles recorded in the entry points to the city of Hermosillo. Using this flow, and the most restrictive segment along this urban route (two lanes with speed bumps), we obtained an estimate of the capacity of this segment of the highway network. As it turned out, there are only two other more restrictive segments along the entire highway network analyzed: just north of Mariposa POE and the entrance to the city of Tucson, both the in the US side of the border.

Table 7.1 – Capacity Estimates for the different nodes in PCPH

Node	Lanes	Volume/Hour	Capacity/Hour	LOS
Guaymas	2	268.15	1180.33	0.23
Toll 1	3	140.00	1050.00	0.13
Hermosillo	2	556.05	1142.86	0.49
Toll 2	3	356.27	1050.00	0.34
Benjamin Hill	2	226.17	702.00	0.32
Santa Ana	2	173.71	1152.00	0.15
Toll 3	3	224.00	1050.00	0.21
Imuris	2	224.16	1152.00	0.19
Toll 4	3	294.00	1050.00	0.28
Nogales, AZ	2	872.00	1672.00	0.52
Tucson	2	4314.00	4271.00	1.01

Other nodes of the highway network that can potentially be the bottleneck of the network is at Benjamin Hill, Sonora. In this point there is a military checkpoint in which all the busses and trucks going thorough it are inspected. Since we did not have access to direct data on traffic or inspection times at this facility we collected anecdotal data from interviews with trucking companies that use the Corridor, among them Transportes Pitic, which is a trucking company based in Sonora (Cons, 2005). According to these interviews we estimate an average wait in this checkpoint of one hour. However, we have received anecdotal information that this time can increase to up to 3.5 hours in the high season according to data collected by SCT (Armenta, 2005). Table 7.1 summarizes our findings related to highway capacity and utilization. A detailed discussion on how the results in this table were obtained is presented in Appendix F.

7.1 Summary of Highway Capacity

From the information collected at the different traffic stations located in Mexico and the US, we were able to calculate the critical flow per hour at different segments of the highways. With this data and the information collected about the physical infrastructure of the highways, we were able to estimate the current capacity and utilization of the corridor highways. The results obtained are presented in Figure 7.2 and Figure 7.3 and summarized in Table 7.1.

These results show that currently the highways from Guaymas to Tucson seem to have enough capacity to handle additional traffic. Since the operation of the container terminal will only increment a fraction of at most 1-2 percent (e.g. from .20 to .22) of the current level of demand, as it will be explained in Section 9, we expect that the operation of a container terminal in the Port of Guaymas would not affect the current highway utilization in a significant way. The impact of the operation of the Port of Guaymas on the Mariposa Port of Entry was previously analyzed in Section 6.

Two points of concern are the City of Tucson and the checkpoint station at Benjamin Hill. The highway segment connecting the Interstate Highway I-19 to Interstate I-10 presents high levels of utilization. However, we believe that this corresponds to the rush hour of the City of Tucson, and the utilization of this highway segment for the rest of the day is significantly lower. Regarding Benjamin Hill our concern lies on the lack of hard data to support our capacity estimates. We feel that this facility should be studied in further detail to provide a better characterization of its current capacity utilization.

8 Analysis of Railroad Infrastructure Supporting the Port

The analysis of the railroad infrastructure was divided into the following activities:

1. Gathering information about the current railroad infrastructure from ADOT, UP and Ferromex.
2. Identify the main (modal interchange) nodes in the system.
3. Developing the appropriate models for the analysis of the railroad network.
4. Determination of current state of the railroad network and the effects of added traffic caused by the operation of a container service in the Port of Guaymas.
5. Estimation of the capacity and its utilization in each of the components of the railroad network.
6. Identification of the bottleneck points.

The second major transportation mode researched are the railroad linking Guaymas to Nogales, Sonora and Nogales to Tucson, Arizona. These railroad segments are owned by private companies. The segment between Guaymas and Nogales is owned by Ferromex and the line from Nogales (AZ) to Tucson is owned by Union Pacific. Union Pacific also owns the main line from Tucson to El Paso, Texas and from Tucson to Yuma, Arizona. Although for all practical purposes these are separate companies, Union Pacific has a stake in Ferromex, so there is some potential for coordination between the two companies. A combined network is presented in Figure 7.1, and a detailed description of the railroad line is presented in Appendix E.

For the railroad, the main nodes identified are the intermodal and inspection terminals in the Port of Guaymas, the Port of Tucson and the DeConcini port of entry/Rio Rico (which are considered as a single node for the purpose of this analysis). For these facilities (with the exception of the Port of Guaymas) we use a rough estimate of their capacity based on standard capacity calculations for railroads. There are also other nodes in the system where the trains are processed; these include the switching yards of Empalme, Nogales and Tucson. In the case of the railroads the military inspection of the cargo does not occur at Benjamin Hill, but at the station of Empalme according to UP and Ferromex personnel. The inspection at Empalme lasts around 2-3 hours per train and takes place before the cars leave the terminal of Empalme. Military personnel inspect the cars while the trains are being formed at Empalme. This operation is similar to the inspection operation of the trains performed by US Customs at Rio Rico, in the sense that there are some cars that US Customs personnel request to be set aside for further inspections.

In order to estimate the capacity of the different components of the railroad network we used the guidelines set forth in the study Parametric Analysis of Railway Line Capacity (Federal Railroad Administration, 1975), which provides a rough estimate of the capacity of uniform line segments between rail stations. The main information that we used for our calculations included the average speed of the trains on each particular segment, the average space between sidings, and the type of control used to coordinate the trains. For the partition of the line segments we used the main railroad stations, which resulted in a line segment between Nogales and Tucson, a second one between Empalme and Hermosillo a third one between Hermosillo and Benjamin Hill and the last one between Benjamin Hill and Nogales.

The information gathered to calculate the capacity of the railroad corresponding to Ferromex was documented through interviews with the key Ferromex personnel involved in the operations. In Appendix F we include some of the data provided by Ferromex. Figure 8.1, shows the capacity and the utilization of the railway in the Ferromex part of the Corridor. In this figure the capacity is given in trains per day and the utilization is given as a fraction of the total capacity available. In Table 8.1 we present the results of capacity estimation for the whole Corridor. The first column identifies each of the railroad segments in which we divided the Corridor; the second column presents the average allowable speed for each of the segments. The third, fourth and fifth columns shows the assumptions about block signals, length of segment and average distance between sidings for each segment (please refer to Appendix F). Finally columns sixth presents the calculated capacity of the railroad (in trains per day) and column seventh shows the current flow through the railroad, and the last column is the current utilization of the capacity.

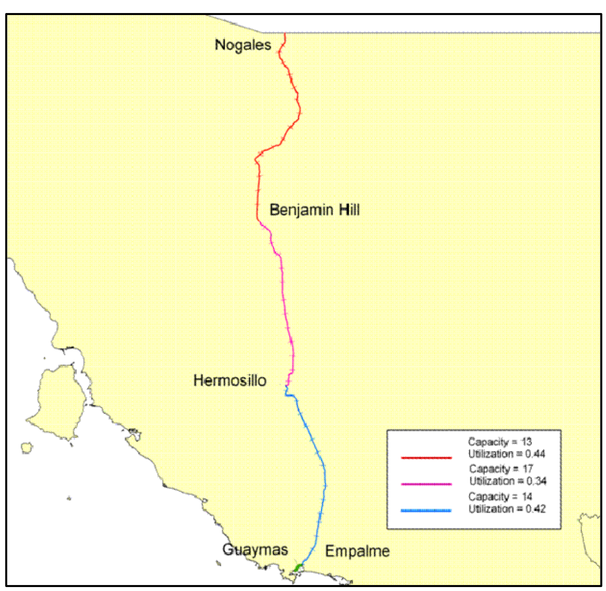

Figure 8.1 – Utilization of the Ferromex's Tracks

As shown in Table 8.1, the capacity of the line with the current infrastructure in place can support up to 14 trains per day in both directions. The utilization of the track was calculated based in the current daily schedule (6 trains per day) for the Empalme-Benjamin Hill line and the Benjamin Hill-Nogales line (6 daily trains). Thus, the highest utilization of the railroad in the Mexican side of the railroad is in the segment between Benjamin Hill and Nogales. These segments have a capacity of up to 13 trains per day and receive an average of 6 trains per day, then using 44% of their current capacity.

Table 8.1 – Capacity Estimates for Different Segments of the Railroad (Trains per Day)

Segment	Speed	Block	Sidings	Length	Capacity	Volume	Utilizatio
Enpalme-Hermosillo	43	1	45	87	14	6	42%
Hermosillo-B.H.	46	1	37	78	17	6	35%
B.H.-Nogales	38	1	44	90	14	6	44%
Nogales-Tucson	35	1	29	65	19	6	31%

For the UP line from Nogales to Tucson, we used the same type of information, but this time we obtained the data that is publicly available through ADOT and the Federal Railroad Administration (Federal Railroad Administration, 2005), which include data on crossings and demand. Using the same methodology that it was used to calculate the capacity for the Mexican side of the railroad we calculated the current utilization of the railway between Nogales and Tucson (Figure 8.2). We obtained a rough estimation that 31% of the capacity of the line is currently being used, assuming that the current demand is at five trains per day, although there are reasons to believe that this level is already at six trains per day.

In order to validate our findings we presented the results of the capacity analysis to Joaquin Rojo de la Vega, Ferromex Vice-president for the Northwest region and Bob Naro, Vice-president of Mexico Operations of UP, during a meeting on January 5, 2006 at Tucson. While both Mr. Rojo De la Vega and Mr. Naro in general agreed with the results presented we did not obtained a formal technical endorsement of our findings. However, we have had additional interactions with Ferromex personnel that served as the basis for our analysis.

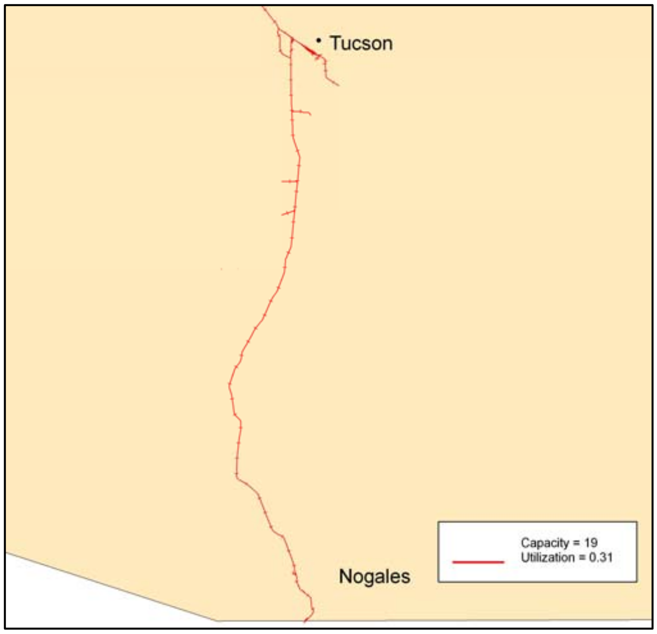

Figure 8.2 – Utilization of UP's Tracks

The main result from the analysis of both railways is that there is still enough capacity to grow in terms of trains per day, but we did not estimate the capacity at the main switching yards in Empalme and Tucson. However, Ferromex personnel assured us that there was enough capacity to support the container activities of the Port of Guaymas. We have reasons to believe that one of the main congestion points in the binational railway corridor could be the switching yard at Tucson, this notion was ratified after meeting with Bob Naro, however he did not express a concern over this issue since apparently UP is already adressing this issue. Even if the numbers in Table 8.1 change when the Ford plant in Hermosillo, Sonora is fully operational; the total requirements from the Port of Guaymas would be two additional trains, one each way, to handle all the different scenarios we mentioned in Section 5.

According to UP the main restriction for the operations of railroad service between Nogales and Tucson is the operational schedule of the customs officers at the DeConcini Port of Entry and at the site in Rio Rico (Figure 8.3 and Figure 8.4). According to UP these inspections require around 2-3 hours per train. The inspection time at Rio Rico, coupled with the operating time at the DeConcini POE (approximately 10 hours) would reduce the amount of northbound trains to around 3-4 trains per day, and the same would apply for southbound trains, bringing the maximum capacity at around eight trains per day, which is significantly less than the physical capacity. Our estimation of the current railroad capacity is consistent with the information provided by CBP field personnel and later corroborated by DHS personnel (see letter in Appendix J). However, DHS staff disputes the claim that the CBP inspections are the cause of the reduction of rail capacity. In a letter from Donna de la Torre, Director of Field Operations, Bureau of Customs and Border Protection; received on April 25 of this year (see Appendix J for a copy of the letter), she seems to indicate that the main factors affecting the delays of the trains at the border are the required train break check procedures, the lack of punctuality of the northbound trains of crossing the border and the crew change that takes place at the border. Since we did not have access to the inspection facilities, we were not able to assess the particular factors affecting the delays. However, while not part of the scope of work of the project being reported, we believe that a closer analysis of the railroad processing procedures is needed in order to establish procedural and infrastructural improvements. This is left as a recommendation for further investigation

Another issue raised by Union Pacific during the meeting was the lack of equipment in Rio Rico to meet the inspection requirements of US customs for a double-stacked container train. For instance, if US Customs personnel needed to inspect the contents of a container located in the bottom of a double-stacked platform the top container would have to be lifted to allow the access to the container at the bottom. This would considerably delay the inspection of the train, if not making the inspection impossible because currently there is no container crane available to make this maneuver possible. A potential way to make this inspection operation more efficient would be to disengage the platform at the Rio Rico and allow the train to continue on to Tucson. However, this is not feasible because the Rio Rico siding is not designed to serve as a switching yard, for a detailed description of the operating procedure at DeConcini and Rio Rico facilities, read Appendix D. A better alternative, that we recommend be explored in the future, is to perform the inspection operation at Tucson. From the letter from Donna de la Torre, mentioned above, it seems that CBP is willing to further discuss this option. This is left for further analysis.

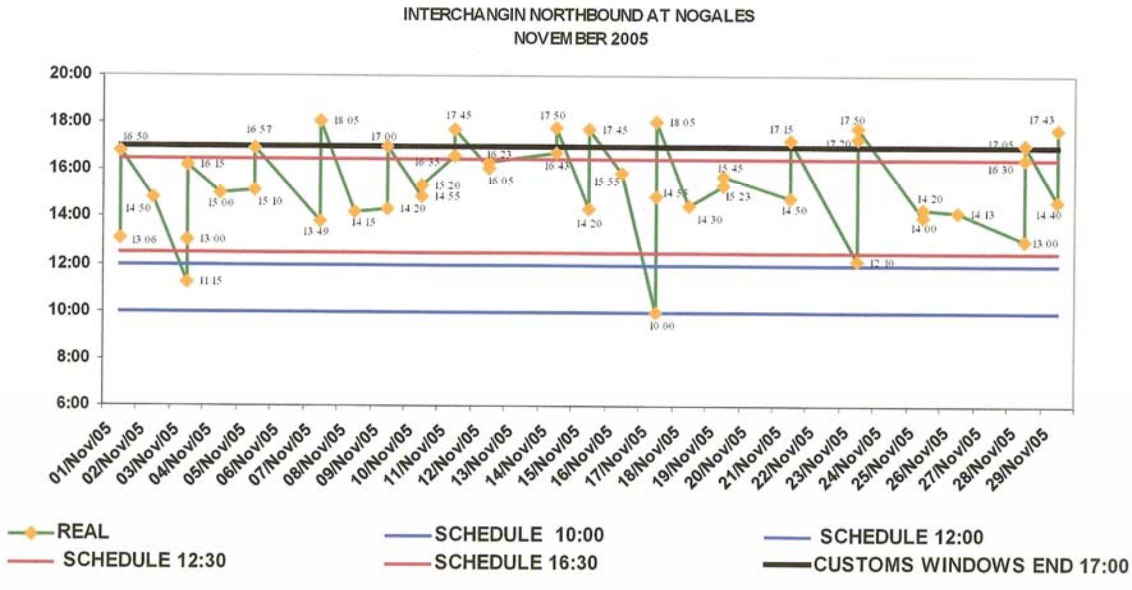

Figure 8.3 – Northbound Rail Crossings at the Border (Provided by Ferromex, 2005)

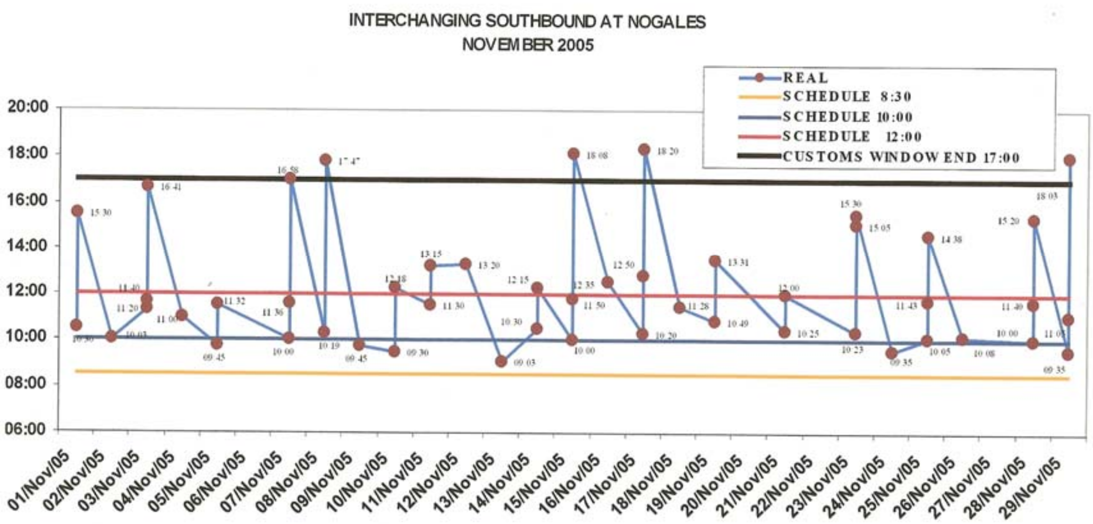

Figure 8.4 – Southbound Rail Crossings at the Border (Provided by Ferromex, 2005)

We also researched the railway in terms of existing and necessary weight and clearance capacity to handle double stacked trains from the Port of Guaymas to the city of Tucson. From empirical data, of the cars transported from the Ford plant in Hermosillo to Tucson, we know that currently there is enough clearance to handle double stacked containers from Hermosillo to Tucson. Thus, we just needed to document the segment Guaymas-Hermosillo to complete this part of the study. We performed a physical inspection of the railroad from Hermosillo to Guaymas, documenting the overpasses and the clearance limitations. The resulting information is shown in Table 8.2, Table 8.3 and Figure 8.5. After getting the specifications and physically inspecting the overpasses for the Guaymas-Nogales railway and the physical inspection of the line we could not find any major restriction to the operation of double stacked container trains for the Guaymas-Nogales segment.

Figure 8.5 - Overpasses in the Railway Guaymas-Hermosillo

The previous capacity analysis is based on the assumption that both companies, Ferromex and UP, have enough equipment, i.e., engines, container platforms, etc, to make an efficient use of the currently installed physical rail infrastructure.

A final note is regarding the effect of the additional trains on the cities of Nogales, Arizona and Nogales, Sonora. While we did not perform a specific analysis in this regard, we made the assumption that the additional train will have to observe the current Uniform Vehicle Code (Federal Railroad Administration, 2006) related to not block an urban intersection for more than 5 minutes continuously. Being this the case, we believe that the marginal impact to Nogales, Arizona should be minimal. However, a more detailed analysis could be undertaken to determine the specific impact to Nogales, Arizona. The same conclusion could be applied to Nogales, Sonora with one additional comment: Nogales, Sonora is also impacted by the train's traverse by the City. We assume that the wait of the train to cross to the US side of the border is efficient and expedient. A more detailed analysis of the crossing operation could be performed to verify this assumption.

Table 8.2 – Specifications for Overpasses

Ferrocarril Mexicano

SUBDIRECCIÓN DE OPERACIÓN
DIVISIÓN HERMOSILLO

GALIBOS EN EL TRAMO DE NOGALES A EMPALME, SONORA.

NOMBRE	UBICACIÓN	ANCHO	ALTURA DEL HONGO DE RIEL	LINEA	OBSERVACIONES
PUERTA DE INSPECCIÓN ADUANAL	Km. T-4+190	4.36		T	ESTRUCTURA METALICA INSP. UNID.
PASO INFERIOR ENCINAS	km. T-9+650	8.10	6.85	T	CRUCE CARRETERO
PASO INFERIOR ENCINAS	Km. T-9+700	8.10	6.85	T	CRUCE CARRETERO
PASO INFERIOR	Km. T-150+033	32.00	8.40	T	CRUCE PEATONAL
PASO INFERIOR PTO. GONZALITOS	Km. T-153+910	8.10	6.85	T	CRUCE CARRETERO
PASO INFERIOR PTO. GONZALITOS	Km. T-153+960	8.10	7.20	T	CRUCE CARRETERO
PUENTE RIO SONORA	Km. T-279+720	4.58	7.16	T	ESTRUCTURA METALICA PASO INFERIOR
PASO INFERIOR	Km. T-409+937	15.60	7.54	T	CRUCE CARRETERO
PASO INFERIOR	Km. T-416+094	23.63	7.42	T	CRUCE PEATONAL
PASO INFERIOR	Km. T-422+300	18.00	8.60	T	CRUCE CARRETERO

Table 8.3 – Translation of the Specifications for the Overpasses (in feet)

Name	Location	Width	Height	Line	Observations
Customs inspection	Km T-4+190	14.30	22.46	T	Metallic structure for inspection unit
Overpass at Encinas	Km T-9+650	26.56	22.46	T	Road crossing
Overpass at Encinas	Km T-9+700	59.04	22.46	T	Road crossing
Overpass	Km T-50+033	26.56	27.55	T	Pedestrian crossing
Overpass at Gonzalitos	Km T-153+910	104.96	22.46	T	Road crossing
Overpass at Gonzalitos	Km T-153+960	26.56	23.61	T	Road crossing
Bridge Rio Sonora	Km T-279+720	26.56	23.48	T	Metallic structure over the bridge
Overpass	Km T-409+937	15.02	24.73	T	Road crossing
Overpass	Km T-416+094	51.16	24.33	T	Pedestrian crossing
Overpass	Km T-422+300	77.50	28.20	T	Road crossing

8.1 Summary of Railroad Capacity Analysis

From the information gathered by interviews with Ferromex and UP and the public information available at ADOT and the Federal Railroad Administration (FRA), we calculated the capacity of rail segments along the corridor and the current level of utilization of the line. The results of obtained are presented in Figure 8.1 and Figure 8.2.

The current capacity of the railroad's physical infrastructure seems adequate to handle the service demand imposed by the different scenarios analyzed for the operations of the Port and the Corridor. However, this capacity seems to be restricted by the current inspection procedures and railroad operations at the City of Nogales, AZ.

9 Overall Corridor Analysis

The purpose of this part of the analysis is to unify the findings from the analysis of different components of the corridor, identifying the current and potential bottlenecks for the flow of containers from the Port of Guaymas to Tucson. At the end of this section we address some operational and commercial issues that emanated in the course of the study, either from the meetings we had with the different stakeholders or from information we researched.

The overall corridor analysis was divided into the following activities:

1. Identification of the most critical points, or potential bottlenecks documented in previous studies.
2. Determination of the different scenarios for the analysis of the Corridor:
    a. Current situation (no containers moving through Guaymas).
    b. Baseline for the initial operation of the Port of Guaymas.
    c. Baseline with a moderate increase in the number of containers moving through Guaymas.
3. Determination of performance measures for the analysis of the corridor.
4. Determination of the capacity and utilization of the Corridor capacity for the different scenarios.
5. Identification of the bottlenecks for the different scenarios.
6. Proposing some potential solutions aimed at improving the overall performance of the Corridor.
7. Analysis of complementary operational and commercial factors of the Corridor.

For the purposes of this study, we defined the logistical corridor between Guaymas and Tucson as a Railroad and Highway corridor with multimodal connections at the Port of Guaymas and the Port of Tucson. The first activity for this study was to identify the infrastructure currently in place for highways, railroads and multimodal terminals.

As part of the analysis we divided the infrastructure of railroads and highways into nodes and links. We defined links as segments of the road or railroad that have similar characteristics in terms of infrastructure, such as lanes, cargo capacity, clearance, and so forth. Nodes were defined as places where transfers between modes can occur or where the performance conditions are different, such as in populated places, toll booths or ports of entry (see Appendix E). These nodes are primarily analyzed individually in this study.

For the overall evaluation of the corridor with the selected performance measures, we analyzed several scenarios that are consistent across the simulations in the Mariposa POE and the Port of Guaymas. The scenarios we explored were:

- Current conditions without container terminal in Guaymas.
- Container terminal running at the minimum required level (400 TEU).
    - 100 % Trucks from the port
    - 100 % Train from the port
    - 50% Trucks and 50% Train
    - 70% Trucks and 30% Train
    - 30% Trucks and 70% Train
- Container terminal running at the medium level (1,200 TEU).
    - 100 % Trucks
    - 100 % Train
    - 50% Trucks and 50% Train
    - 70% Trucks and 30% Train
    - 30% Trucks and 70% Train
- Finally with 2000 loaded TEU per week.
    - 50% Trucks and 50% Trains

The capacity estimates for these scenarios are presented next.

9.1 Current Capacity and Utilization of the Corridor

As part of the activities of the study we estimated the current capacity and the utilization for the main nodes and links for the railroads and the highways of the Corridor. The current capacities and utilization the railroads and highways are documented in Table 9.1 and Table 9.2 respectively. These tables show that with the exception of the intersection of the highways I-19 and I-10 in the City of Tucson, the rest of the elements of the corridor seem to have enough capacity for additional traffic. We believe that the lack of capacity exhibited by the I-19 and I-10 intersection is a transient occurrence only observed at the peak hour of the morning and afternoon commute. Thus, we did not consider this intersection to be a bottleneck for the corridor.

However, a more detailed analysis should be undertaken to determine the exact effect of additional traffic in this segment of the highway.

Table 9.1 – Estimation of Capacity and Utilization of Railroads

Segment	Speed	Block	Sidings	Length	Capacity	Volume	Utilization
Empalme-Hermosillo	43	1	45	87	14	6	42%
Hermosillo-B.H.	46	1	37	78	18	6	34%
B.H.-Nogales	38	1	44	90	14	6	44%
Nogales-Tucson	35	1	29	65	19	6	31%

Table 9.2 – Estimation of Capacity and Utilization of Highways

Node	Lanes	Volume/Hr	Capacity	Utilization
Guaymas	2	268.15	1180.33	23%
Toll 1	3	140.00	1050.00	13%
Hermosillo3	2	556.05	1142.86	49%
Toll 2	3	356.27	1050.00	34%
Benjamin Hill	2	226.17	702.00	32%
Santa Ana	2	173.71	1152.00	15%
Toll 3	3	224.00	1050.00	21%
Imuris	2	224.16	1152.00	19%
Toll 4	3	294.00	1050.00	28%
Nogales, AZ	3	872.00	1672.00	52%
Tucson	2	4283.00	4271.00	100%

Table 9.3 presents the information related to the current capacity and utilization nodes that were not included in the previous tables. From the utilization reported in this table, and as it was mentioned in Sections 7 and 8, the current main bottlenecks of the corridor appear to be the inspection points at the border. Both transportation modes, rail and trucking, have their main restrictions when crossing northbound to the US. In the case of trucks, from information provided by CBP personnel and the simulation model, we have estimated the maximum number of trucks that can be processed daily at Mariposa POE which under current operational schedules is around 1,500 trucks. Since, we also know that the current daily demand at the annual peak season is of about 1,300 trucks, the most additional traffic that can be handled without significantly modifying the current operational schedule is of about 200 trucks per day or only 104,000 TEU per year. Also, due to inspection time requirements and railroad operations in Nogales (see Section 8), currently only up to 8 trains per day can cross the border, which means only one additional northbound train per day can send through the corridor. This additional train corresponds to a total of 120,000 TEU per year (Table 9.3).

The main intermodal nodes in the corridor are located in Guaymas, Hermosillo and Tucson. The container capacity of the Port of Guaymas has already been estimated at more than 175,000 TEU per year (according to our simulation results) and the capacity of the Port of Tucson is at 295,000 TEU per year (Levin, 2005). We do not have an estimate for the intermodal terminal in Hermosillo, but since it is not economically viable to load containers in trains of cargo bound for the Port of Guaymas or unload trains coming from Guaymas, then it is not a feasible alternative for the corridor.

Table 9.3 – Estimation of Capacity and Utilization of Highways

	Mariposa	Guaymas	Port of Tucson	Nogales
Capacity	1,500	600	640	400
TEU	3,000	1,020	1,114	1,600
Days	260	172	300	300
Cap TEU	780,000	175,440	334,000	480,000
Current	676,000	0	30,000	360,000
Available	104,000	175,440	304,000	120,000
Utilization	87%	0%	9%	75%

From Tables 9.1 to 9.3 we can see that the current bottlenecks of the Guaymas-Tucson corridor correspond to the Mariposa POE, followed by the DeConcini POE/Rio Rico and the Port of Guaymas. We estimate the current capacity of the corridor is 175,000 TEU if both ports of entry are operational and a railroad container service between Guaymas and Tucson is available. However, this capacity is reduced to 104,000 TEU per year if the railroad service is not available. On the other hand, the current capacity for the corridor would be of 120,000 TEU per year, if only train is used to move the containers from Guaymas to Tucson. In this case, the main factor limiting the capacity of the Corridor would be the train procedures performed at the DeConcini Port of Entry and/or Rio Rico facilities.

An overall summary of the Corridor capacity is offered in Table 9.4. The capacities for the highways are given in trucks per day, which is obtained by assuming that every truck is equivalent 1.5 passenger vehicles. For the case of the railroad the capacities are given in containers per day, which is calculated based on the assumption of 100 cars per train with four TEUs per car. To determine the capacity of the overall corridor we assumed an operation of the highways and terminals of 12 hours per day, which are the hours of operation at the Mariposa POE at maximum capacity (From 8:00 AM – 8:00PM). Thus, the Port of Guaymas can process 50 containers (trucks) per hour which would be equivalent to 600 Containers per day for imports.

If the reader needs to reconcile these numbers to TEU, the ratio of TEU to container is 1.74, using a mix of 20' and 40' containers of 26-74% respectively.

From the previous discussion, from a physical infrastructure perspective, we believe that the current capacity of the Guaymas-Tucson is 175,000 TEU per year if both rail and truck service to move containers between Guaymas and Tucson are available. Thus, we believe the current unavailability of efficient rail service to move containers between Guaymas and Tucson is a very important limiting factor for the operation of the Corridor.

Table 9.4 – Current and Available Daily Capacity of the Overall Corridor

Corridor Components	Modal Capacity				Modal Capacity			Overall Corridor		
Higway	Capacity	Used	Available	**Railroad**	Capacity	Used	Available	Capacity	Used	Available
Links				**Links**						
Guay-Empalme	9,664	3,157	6,507	Guay-Empalme	1400	200	1200	11,064	3,357	7,707
Empalme-Her	26,650	3,142	23,508	Empalme-Her	1400	600	800	28,050	3,742	24,308
Her-B. H.	22,204	5,026	17,178	Her- B.H.	1600	600	1000	23,804	5,626	18,178
B.H.-Imuris	26,057	2,034	24,023	B.H.-Nog	1400	600	800	27,457	2,634	24,823
Imuris-Nog	17,818	2,322	15,496					17,818	2,322	15,496
Nog-Mariposa	28,082	3,524	24,558					28,082	3,524	24,558
Mariposa-I19	32,464	13,828	18,636					32,464	13,828	18,636
I19-Tucson	30,464	26,092	4,372	Nog-Tucson	1800	600	1200	32,264	26,692	5,572
Nodes				**Nodes**						
Guaymas Port*	600	0	600	Guaymas Port	0	0		600	0	600
Hermosillo	9,143	5,004	4,139					9,143	5,004	4,139
Guaymas	9,440	2,358	7,082					9,440	2,358	7,082
Santa Ana	9,216	1,566	7,650					9,216	1,566	7,650
Mariposa	1,500	1,296	204	Nogales,AZ	800	600	200	2,300	1,896	404
Nogales, AZ	13,376	7,429	5,947					13,376	7,429	5,947
				Port of Tucson	640	100	540	640	100	540
Tucson**	34,168	35,635	0					34,168	35,635	0
Total	1,500	1,296	204		800	600	200	2,300	1,896	404

*Assuming a terminal with two quay cranes in Guaymas.
+ We assume also 12 hours to convert to a capacity per day.
+ With 100 cars per train and 2 Containers (40') per car.
** Capacity estimation at peak hour, since is a transient occurrence, we do not consider this a hard bottleneck.

9.2 Utilization of the Corridor with a Terminal Container at Guaymas

In this sub-section we perform an abbreviated sensitivity analysis to revise our estimates of capacity for the different elements of the Corridor to reflect the operation of a container terminal in the Port of Guaymas. We used the output from the simulation of the Port of Guaymas as input for the rest of the corridor, with a similar procedure as we did with the simulation for the Mariposa POE. For example in one of the scenarios the demand for the highway would be increased by 239 containers per day, which adds 239 more trucks to the current average daily flow of the Corridor. For the case of the trains we estimated that one additional train in both directions (northbound and southbound) should be more than enough for handling all the containers coming in and out of the port for all the different scenarios (Table 9.5). Another motivation for programming a daily train is to reduce the waiting time for containers leaving the port by rail. However, we need to mention that the addition of one train in each direction would represent a worse case scenario in terms of the rail capacity needed.

With the additional demand, the effects on the highways are between 1-2% of increase in the utilization (volume/capacity) of the different segments (Table 9.6). Thus, we conclude that given this minor increase, the operation of the port at the levels selected in the simulation would not significantly impact the highways. The main constraints for the highways are the inspection points at Benjamin Hill and the Mariposa POE. From the results of the simulation the nominal utilization for the Mariposa POE would increase to over 100% (see Table 6.2). In theory, this is not possible. However, our assumption is that this over utilization would be addressed by increasing the operating hours of the POE, as it is currently done to process the produce at the peak of the harvesting season. We estimate that the additional time to process the added traffic would be of around two hours. These estimations are based on the results provided by the simulation model which was built on data provided by CBP personnel. We recommend that a more detailed analysis of Mariposa POE is undertaken to verify our findings and to analyze improvements.

Table 9.5 – Capacity and Utilization with a Container Terminal in Guaymas

Segment	Speed	Block	Sidings	Length	Capacity	Volume	Utilization
Empalme-Hermosillo	43	1	45	87	14	8	56%
Hermosillo-B.H.	46	1	37	78	18	8	46%
B.H.-Nogales	38	1	44	90	14	8	58%
Nogales-Tucson	35	1	29	65	19	8	42%

Table 9.6 – Capacity and Utilization with Terminal in Guaymas

Node	Lanes	Volume/Hr	Capacity	Utilization
Guaymas	2	280.72	1180.33	24%
Toll 1	3	140.00	1050.00	13%
Hermosillo3	2	567.10	1142.86	49%
Toll 2	3	366.02	1050.00	35%
Benjamin Hill	2	238.49	702.00	34%
Santa Ana	2	182.78	1152.00	15%
Toll 3	3	234.17	1050.00	22%
Imuris	2	234.17	1152.00	19%
Toll 4	3	308.50	1050.00	29%
Nogales, AZ	3	889.85	1672.00	53%
Tucson	2	4298.00	4271.00	101%

For the case of the railroad, the increased demand would require two more trains going through the corridor, one going south from Tucson to Guaymas and one going north from Guaymas to Tucson. This flow would generate a utilization (volume/capacity) of the physical capacity of the railroad of up to 58 %, and a full utilization of the railroad facilities at Nogales, AZ (DeConcini and Rio Rico). For this mode of transportation would be a substantial change from the current levels, however in terms of physical capacity this number would still be manageable..

Another analysis consisted on determining the Average Travel Time (ATT). The ATT was calculated according to the data provided by several carriers and shippers that currently use the corridor (Table 9.7), to this time we added the waiting time at the border (Cano, 2005; Roy, 2005; Maldonado, 2005). The traveling time in the table assumes a waiting time of one hour at Benjamin Hill, which is the normal waiting time during off-peak season, however this estimate may be revised in the future since we have information that this time can be up to 3.5 hours in the peak season.

The estimated travel time by highway is based on average travel speeds provided by interviewed companies and by the maximum allowed speeds in different roads in the US and Mexico. We also included inspection times in Mexico and at the border. The summary of these results is presented in Table 9.7.

Table 9.7 – Average Transit Times by Truck

	Travel Time (Hours)					
Highway	Hermosillo	Nogales	Tucson	Phoenix	El Paso	Chicago
Guaymas	2	6*	9**	11	14	35
Hermosillo	0	4.5	7**	9	12	33
Tucson	6	1	0	2	5	26
Long Beach	7	8	7	5.5	12	30

* Assuming an average of one hour of inspection at Benjamin Hill.

** Assuming one hour of waiting time at the border.

In the case of the railroad, the travel time was calculated based on historical information for the year 2005 provided by Ferromex (Ferromex, 2006). For the UP line we estimated the time with the reported travel speeds, schedules and waiting time at the border (UP, 2006; Association of American Railroads, 2006). One limitation of this approach is that we are not taking into account the waiting time of trains at the UP stations, since we did not have actual the performance reports of the trains in these routes, so the traveling time of the railroad in the US might be underestimated. However, for the Mexican railroad we have historical reports provided by Ferromex, and their performance of trains traveling from Empalme to Nogales takes an average of 14 hours with a standard deviation of around 2 hours. The summary of the travel information without is presented on Table 9.8.

Table 9.8 – Average Transit Times by Railroad

	Travel time (Hours)					
Railroad	Hermosillo	Nogales	Tucson	Phoenix	El Paso	Chicago
Guaymas	4	14	18*	22	31	85
Hermosillo	0	10	14	18	27	81
Nogales	10	0	4	8	17	71
Tucson	12	2	0	4	13	67

*Assuming a 2 hour wait at the border

We added the waiting time of the containers at the port to the regular traveling speed to get an estimate of the time it takes for a container to travel all the way to Tucson once it has arrived at the Port of Guaymas.

9.3 Complementary Analysis

Since currently there is not a container service between Guaymas and Tucson and it is not clear if and when this service will be offered we did a very preliminary analysis of the current cost of transportation of containers from the Port of Guaymas to Tucson and Phoenix.

Since currently there are no railroad services to transport containers from the Port of Guaymas to Tucson we wanted to investigate the commercial feasibility of using truck instead. In order to pursue this goal, we obtained cost information from two different trucking companies for transporting a 40' container from the Port of Guaymas to Tucson and Phoenix. The prices that we obtained from these companies were of around $1,300 to move a container from Guaymas to Tucson. This is equivalent to $3.98 /container-mile. If we compare this rate with the rates that can be obtained in the USA we see a dramatic difference. For instance, in the USA the truck-mile-traveled per 40' container is estimated to cost $1.76 and the same rate is $1.06 per train-mile for the same container according a study prepared for the U.S. Department of Transportation (Reeves & Assoc., 2005). On the surface, it would seem that the current rate obtained to move a container from Guaymas to Tucson would make the Guaymas-Tucson corridor commercially infeasible. However, we believe that the rate quoted corresponds to moving an empty container from Tucson to Guaymas and loaded from Guaymas to Tucson, this is because of the lack of a sea-container yard in Guaymas. Because of this, we believe that the proper rates should be set around 2 $/truck-container-mile and 1.2 $/train-container mile. Under these rates we estimate that a container moving from Guaymas to Tucson would be competitive with a container moving from

Long Beach to Tucson only if it moves by train. The same trend has been observed in the US, where the containers are mainly moved by rail instead of truck (See Figure 9.1). This is a very rough analysis, but it serves to highlight the importance of having a rail service to move containers from Guaymas to Tucson, and to have all the required systems in place to make that service competitive in terms of cost and time.

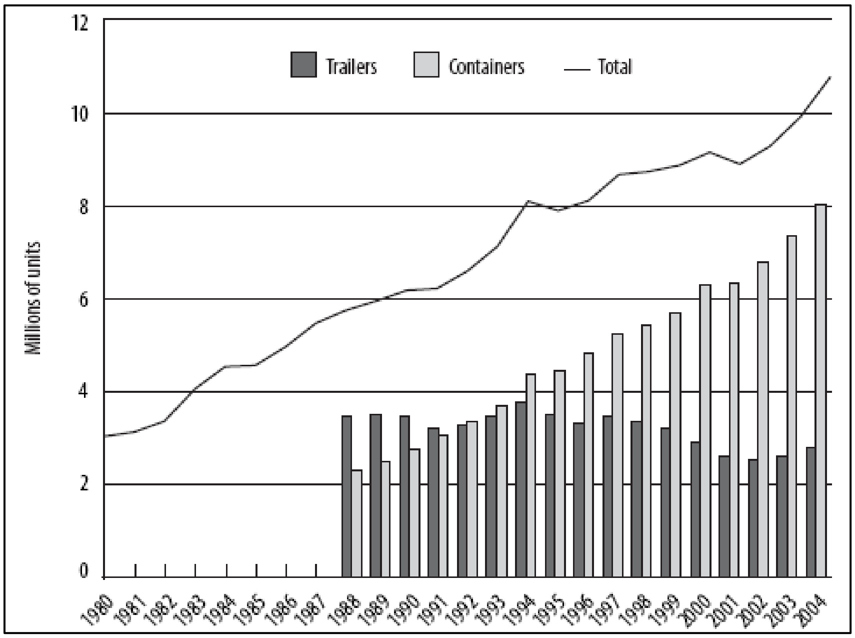

Figure 9.1 – Rail-Truck Intermodal Traffic in the United States: 1980-2004
Source: U.S. DOT "Freight in America", January 2006

9.4 Summary of Findings

Some of the findings derived from this section include:

- We estimate the current capacity of the Guaymas-Tucson multimodal corridor to be 175,000 TEU per year if both ports of entry are operational, and a railroad container service between Guaymas and Tucson is available. However, this capacity is reduced to 104,000 TEU per year if a railroad service is not available. On the other hand, the current capacity for the corridor would be of 120,000 TEU per year, if only rail is used to move the containers from Guaymas to Tucson. In this case, the main factor limiting the capacity of the Corridor would be the railroad inspections and other activities performed at the DeConcini Port of Entry and Rio Rico facilities.

- We estimate that the current main bottlenecks of the physical infrastructure of the corridor are, in order of their impact are: Mariposa POE, the railroads border crossing infrastructure and the Port of Guaymas. These points need to be further studied to verify our findings and to recommend potential improvements if an increase of the current capacity of the Corridor is desired.

Other findings derived from the overall analysis of the Corridor include:

- A major obstacle for the viable operation of the Guaymas-Arizona container service is the lack of a provider of an integrated service that includes shipping lines, railroads and freight forwarding services. In order to make possible this integrated service it is first necessary to have an integrated railroad service for containers between Guaymas and Arizona. In this regard, we were unable to get precise information from the US rail company providing the service, i.e. Union Pacific, on what are the necessary or sufficient conditions –commercial or operational; to service the potential containers generated by the Port of Guaymas. We believe that the railroad companies are indispensable for the creation of an economically feasible container corridor between the Port of Guaymas and Arizona. From their participation in the reported activities, it is clear that *Ferrocarriles de México* (Ferromex) is committed to the realization of the Corridor. In our opinion, the level of commitment, or interest, from Union Pacific is less clear.

- Input from United States (US) rail and truck managers suggests that process changes to make border crossing times more predictable would be very useful to be able to offer efficient services to and from Guaymas.

- Even if container traffic were attracted to the port, US railroads would primarily be interested in Midwest-East destined freight, while Ferromex is willing to handle shorter haul business.

- In our analysis, we have made assumptions about the type of infrastructure and level of service needed to attract a shipping line to establish a port of call by a major container shipping line. However, the exact needs in terms of service and demand should be explored with the shipping companies. This assignment is left as part of the proposed second phase of this study.

- An issue that needs to be addressed as soon as possible is the lack of a regularly scheduled container service to the Port of Guaymas. While the analysis of the requirements to attract a major shipping line to the port was beyond the scope this study, we believe that the geographical position of Guaymas may be an issue to attract, in the short term, a company to provide direct service to Asia. However, we believe that the Port of Guaymas is well positioned to serve as a regional port. For instance, it may be appropriate for Guaymas to concentrate initially on operating as a feeder port for Sonora destined business until regular longer-haul business is instituted by the steamship lines and efficient rail service for containers is secured.

10 Recommended Activities

The main objective of the activities reported in this document was to determine the feasibility, in terms of current infrastructure available, of establishing a regular container service between the Port of Guaymas and Tucson. However, this study should be seen just as a starting point for a more comprehensive analysis whose aim is the development of an efficient intermodal corridor that supports and promotes the economic development of both Sonora and Arizona. We recommend the as a follow up to this study the following activities are pursued:

- Refinement of the capacity study.
- Identification of Infrastructure improvements and their effects.
- Identification of comparative logistics/supply chain advantages of the use of the Port of Guaymas.
- Determination of potential commercial of the Corridor.
- Matching the Logistics advantages with appropriate industry segments.
- Exploration of opportunities of collaboration for value added activities in the Port of Guaymas.
- Preparation of a strategic Road Map for the development of the corridor.

We provide a brief description of the activities we expect to perform in this phase of the study.

10.1 Refinement of the Capacity Study

The results presented in this report correspond to a high-level, coarse resolution analysis. In order to have a better estimation of the overall performance of the corridor we recommend that a more detailed analysis is done. The analysis should pay particular attention those areas that were deemed a bottleneck in the current project. In particular, we recommend taking a closer look at the Mariposa port of entry and DeConcini/Rio Rico facilities and operational activities. We also recommend doing a more detailed study of the effect of the military checkpoints in the Mexican side of the border.

10.2 Identification of Infrastructure Improvements and their Effects

The bottlenecks identified in this study should be candidates for infrastructure improvements that would increase the efficiency of the corridor from a logistics perspective. As first step the appropriate performance metrics that would represent accurately the logistical benefits for the corridor should be established. Once these measures have been determined the projects should be prioritized based on the benefit/cost obtained and proposed to the appropriate decision making bodies.

10.3 Identification of Comparative Logistics/Supply Chain Advantages of the Use of the Port of Guaymas

One of the main attractions in using the Port of Guaymas should be the reduction of the overall logistics costs. A very important driver of logistics costs is the uncertainty of point-to-point transportation time. A study should be pursued to make a relative comparison of the potential services offered by the Guaymas-Arizona Corridor with those offered by the Port of Long Beach and other multimodal corridors. An important part of the study should be the estimation of realistic integrated rates for the corridor. This is important to attract freight forwarders and logistical operators and create the critical mass required to jumpstart the container terminal. Ideally, the participation of key players such as railroads, freight forwarding and steam shipping companies in the study should be secured.

10.4 Determination of Potential Commercial of the Corridor

In the current study we made assumptions regarding the number of containers moving through the Corridor. A study that looks at potential volumes with specific origin and destination should be performed. As part of the study the characterization of the different profiles of the freight potentially moving through the Corridor should be attempted.

10.5 Matching the Logistics Advantages with Appropriate Industry Segments

There are segments of the supply chains of some industries that by its nature they are less tolerant to variability of delivery times. Examples include high cost components and sub-assemblies to be used for final assembly, highly seasonal finished products such as toys and electronics. We believe that these segments of the industry are prime candidates to use container services of the Port of Guaymas.

10.6 Exploration of Opportunities of Collaboration for Value Added Activities in the Port of Guaymas

We believe that Guaymas possess two characteristics that make it an attractive point to attract industries to establish their operations there. First, the labor cost of Guaymas is very competitive with respect to the wages existing in the USA. Second, Mexico is the country with the most free trade agreements in the world. This makes Mexico in general, and Guaymas in particular, an attractive place to establish operations to take a strategic advantage of the lower tariffs charged to products produced (or with a high value added content) in Mexico. A possibility to take advantage of the location of Guaymas would be to send subassemblies that can be packed more efficiently in the containers coming from the Far East. Use these sub-assemblies to assemble the final product in Guaymas and send the final product from Guaymas to the appropriate distribution Center in the US or directly to the final customer. A typical industry that would benefit from this type of operation would be furniture. For instance, sending finished furniture from the Far East to the US is extremely expensive because of the volume occupied by each piece of furniture. In addition, the taxes paid by finished furniture might be more expensive than those paid by subassemblies or those paid by Mexican products. Another related opportunity would be to send unfinished products from the US to Guaymas, add enough value in Guaymas to take advantage of the free trade agreements signed by Mexico with other countries and to send the final product from Guaymas to those countries.

10.7 Preparation of a Strategic Road Map for the Development of the Corridor

This study would identify those activities that should be undertaken in future studies to develop a comprehensive plan for the development of an efficient multimodal Corridor.

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